unior High School
Curriculum Guide
for
GENERAL SCIENCE

PROVINCE OF ALBERTA
DEPARTMENT OF EDUCATION
1951

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FOREWORD

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EDUCATION AND SOCIAL CHANGE

The swift movement of scientific events of the last fifty years has brought home to us a realization that we live in a rapidly changing world. Our grandparents had no telephones, electric lights, gas cookstoves, bathrooms, running water, central heating, electric refrigerators, deep-freeze units, garages, fast automobiles, aluminum kitchenware, factory-canned goods, factory-made clothes, radios, television, sulfa drugs or vitamin tablets. No one travelled by air. The atom bomb and jet propulsion were unknown. Power machines were indeed rare.

Rapid communication brings close together nations which were formerly considered remote. Because of mechanization ever increasing numbers of farm folk are residing in cities while father and son return to the farm to seed and harvest the crop, without horses, and without the attendant chores.

If the school is to contribute to our modern welfare and to social progress, it cannot remain static in a changing world. It must keep pace with social and technological advances in the world of the present by modernizing its methods in terms of a modern age. To fit a child for the world of yesterday would hinder his proper adjustment to our rapidly changing scene. In fact, to fit him for the world of today is short-sighted.

ACKNOWLEDGMENTS

The Department of Education acknowledges with appreciation the contributions of the following committee members to the preparation of this Junior High School curriculum guide for General Science. The guide has been prepared by the subcommittee on Junior High School Science under the guidance of the Junior High School Curriculum Committee.

The Junior High School Curriculum Committee meets twice yearly to receive reports from the various curriculum subcommittees. It makes suggestions and recommendations, sets policy, and finally approves the work of the subcommittees. The final release of the curriculum guides is approved by the Director of Curriculum and final authority for their introduction into the schools of Alberta is granted by the Minister of Education.

Junior High School Curriculum Committee: as of 1951-52.

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The work of a subcommittee proceeds in the following manner: existing courses are evaluated; the philosophy of, and modern trends in the particular curriculum area are studied; the objectives of teaching in the area are outlined; and finally the procedures for obtaining these objectives are formulated. The subcommittee's main task is research, and its ultimate aim the production of a program of study.

The first subcommittee prepared an interim program for the Junior High Schools of Alberta in 1949. The program served as a pilot experiment and was tried out by a number of teachers in Edmonton, Calgary, and in certain selected schools in the various school divisions throughout the province.

The second subcommittee in 1950 prepared an interim revision which was made available to teachers of the province in all Alberta schools during 1950-51.

This final draft of the Junior High School Science Curriculum Guide was prepared by the second subcommittee. It will be introduced into all Alberta schools in September 1951.

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PHILOSOPHY OF SCIENCE TEACHING

THE IMPORTANCE OF SCIENCE IN THE TOTAL SCHOOL CURRICULUM

Science is important in modern living. It has been largely responsible for the advancement of our Canadian civilization. All phases of our living are influenced by the remarkable progress that science has made. In truth, our age is dominated by science. There are but few events in our physical lives in which we have not been helped and made more comfortable by the work of the scientist. Our problems of food, clothing, shelter, communication, transportation, production, distribution, consumption, and conservation are all directly or indirectly related to science.

Everywhere in the world scientists are at work. The scientist has given us the airplane, the submarine, the ocean liner, the automobile and the super-highway. Today scientific knowledge is not only international, but it is also very extensive. In spite of this abundance of scientific knowledge, however, the search for truth and for new information goes on unceasingly.

In our daily activities, from the time we rise until we go to bed, the scientist helps us at every turn. The alarm clock that wakes us up, the clean water with which we wash, the refined white sugar we put on our cereal, the bus we take to school or to work, the movie, the radio program at night, the pure milk we drink before retiring, all have been made possible by the scientist.

If boys and girls are to grow up to be intelligent adults they must from their earliest years learn about science and the scientific method. Because new facts in science are constantly being discovered, every person should learn how the scientist works. The scientist changes his views regarding explanations based on past facts. Science is on-going and ever-searching.

To live wisely in our atomic age, youth of today must possess a basic understanding of science and of scientific principles. Citizens of today and tomorrow must have broad experience in science, must develop a scientific attitude or outlook, and must appreciate to some extent the contribution of science to our welfare and comfort. In the process of learning about science, the student will acquire related skills and information which should help to make him a better consumer and a better informed individual.

THE NEW JUNIOR HIGH SCHOOL SCIENCE PROGRAM

The junior high school science program outlined in this curriculum guide has many new features. It consists of an organized progression of studies in a planned sequence through Grades VII, VIII and IX. The program is also an extension of science experi-

ences which the child has acquired in the Enterprises or Parallel Activities of the elementary grades. In addition, the new Science program provides a suitable background for both the general and special science studies of the senior high school.

As the students investigate various units of the science course, they arrive at certain understandings or general ideas, they develop certain skills, abilities and habits, and acquire certain attitudes. In the process they will use factual knowledge and information. They will not be required to master facts for their own sake, but rather they will use facts as tools or aids in problem-solving situations. Futhermore, boys and girls should learn the scientific way of thinking and acting. They should be given training in defining a problem carefully and clearly, collecting and organizing all available information which bears upon the problem, evaluating data, drawing from the data an hypothesis or general principle, testing the hypothesis to see that it agrees with the available information, using experiments to solve problems, arriving at tentative conclusions, and applying findings in later study or action. As students learn the scientific methods they will naturally develop a scientific attitude.

There is no necessity to foster an inquiring attitude in young people. They are naturally curious. They ask why; they are eager to discover new things and happenings about them. This natural curiosity provides a starting point for science instruction; it is necessary only to make the content sufficiently interesting and the teaching sufficiently vital to keep this natural curiosity alive and to direct it toward new and challenging areas of the child's surroundings.

As a result of pursuing the scientific method in the class, it is hoped that the student will acquire the ability to think clearly, develop an attitude of inquiry, maintain an experimental outlook, and keep an open mind, and that these will carry over into his work in senior high school, in university and in his everyday life.

MODERNIZING THE JUNIOR HIGH SCHOOL PROGRAM

A program of studies in science must foster the personal growth of the child by providing for the development of the child's understandings, skills, abilities and attitudes. The program must provide not only for group activity but also for clear thinking and correct expressions of ideas on the part of the individual child. Factual knowledge and skills in science are by no means to be discarded, but teachers must realize that understandings and attitudes also are of critical significance. Children cannot be taught to do clear thinking in science unless they know how and when to generalize, how to develop scientific attitudes, and how to use skills and abilities in arriving at such understandings and attitudes.

It is felt that the unit study approach to general science learning will better achieve the broader purposes suggested above than will the type of program where science content is formally and logically set out in lengthy outlines of major headings and subheadings. The unit study method is considered more effective in developing skills, abilities, and understandings than is the method of slavishly following a text-book based on an assignment-and-recitation technique.

The following reasons are proposed for modernizing the junior high school science program:

The need for a general overall plan of studies which will meet the needs of all pupils in Grades VII, VIII and IX.

The need to provide a progression, continuity, or sequence in junior high school science studies.

The need to provide unity in the science work of the junior high schools.

The need to provide for the use of the problem-solving or scientific method in the treatment of a series of science studies.

The need to provide for broad outcomes of science teaching and to express them in terms of student behavior in specific unit studies.

The need to strengthen and enrich the teaching of junior high school science: The new science program strengthens and enriches teaching by:

1. Providing for the personal growth of the individual through group activity;
2. Providing opportunities for the student to do original, creative, and clear thinking;
3. Providing opportunities for students and teacher to work cooperatively together in planning studies and activities;
4. Providing opportunities for self-expression and self-criticism;
5. Providing opportunities for students to engage in assigned home-study related to a purposeful phase of a problem, as opposed to memoriter home-study for recitation to the teacher;
6. Providing a democratic classroom situation in a group activity-pattern involving problem-solving, rather than having students sit hour by hour in rigid seat arrangement listening passively to the teacher, or being asked questions;
7. Providing opportunities for all students to participate in science studies according to their level of ability, maturity, and interest; in other words, recognizing the commonly known psychological principle of individual differences;

8. Providing opportunities to discover leadership abilities among a group of students;

9. Providing opportunities to challenge the very bright and the keenly interested student by offering advanced readings and enrichment studies in line with his ability.

THE EXPERIENCE CURRICULUM

The new science curriculum for the junior high school in Alberta is an experience curriculum. It is a basic principle of learning that real understanding can result only from the participation of an active, thinking mind. If this principle is to apply to learning situations, the school must provide experiences that will satisfy the child's natural urge to know and find out. There are three main types of child experiences:

1. *Firsthand or direct experiences*: e.g. making a motor or a water wheel, setting up a laboratory experiment. (The child participates directly.)

2. *Observational experiences*: e.g. observing natural phenomena such as changes in the weather or the position of the stars, or observing artificial phenomena such as manufacturing or industrial processing. (The child does not participate directly.)

3. *Indirect experiences*: e.g. listening, reading; observing films, slides, pictures or charts.

Since this science curriculum provides the child with many types of experience or active learning situations, it is called an experience curriculum. No longer is a child to be viewed as a passive receptacle to be filled with information. In rural areas the child actually gains direct experience with such things as a nearby brook, a rocky hill, or a field that is summer fallow; in urban areas he experiences such things as migrating birds, animals in a zoo, tools and machines used to help man with his work, and the construction of roads, sewer lines and transportation and communication systems.

MAJOR TRENDS IN SCIENCE TEACHING

This program has been planned to conform to the following general trends in junior high school science teaching:

1. *Content*: A series of activities in the form of interesting and worth-while readings, reports, and problem studies.
2. *Method*: The constant use of the scientific or problem-solving method and the continuous development of scientific attitudes.
3. *Application of Content and Method*: A constant emphasis on the human or social implications of science, and the application of the unit studies to our own living.

CORRELATION OF SCIENCE WITH OTHER SUBJECTS

This program correlates Science with three major fields of subject matter: (1) Mathematics, (2) Social Studies, and (3) English.

1. *Science and Mathematics*: In certain units there are excellent opportunities to correlate these two fields. For example, in studies of longitude and time, it is necessary to have a clear understanding of circular measure and to be able to make accurate computations. The proposed "block-scheduling" plan gives the teacher an ideal opportunity to apply mathematical principles in a practical way.

No special unit has been set aside for the teaching of the metric system. In order to be able to interpret readings contained in science texts and references, children need to know the meaning of cubic centimetres, grams, kilograms, etc. The Science teacher need not teach the complete metric system but he should take time in the Mathematics-Science block to teach the essential units of metric measurement.

2. *Science and Social Studies*: These two fields of study go hand in hand, the one strengthening the other in meaning and importance. Many items and units in this course are really socio-scientific in nature and the teacher will readily detect this interrelationship. For example, the obtaining of pure water, the setting up of our pure food laws and the establishing of provincial regulations regarding public health and sanitation all are primarily social studies, but their meaning cannot be fully appreciated without science understandings. An understanding of harmful and beneficial micro-organisms, involves a study of such scientific controls as pasteurization, chlorination, refrigeration and sedimentation.

3. *Science and English*: The field of General Science, with its rich contents and inherent interest, calls for the ability to speak and write correct English.

Science can and should be used to give purpose to the child's self-expresion in both oral and written work. The science teacher should give attention to correct expression, accurate statements, good spelling, and suitable essay work as the various unit studies are carried out. Teachers must take time to direct this important phase of learning.

4. *Science and Health*: No specific unit studies in Health are to be taken up in this program. The topic of micro-organisms, however, is considered to be an appropriate science study and is dealt with in Unit 2 for Grade VIII (see page 82) as a study in interdependence.

THE SCIENCE PROGRAM, A GUIDE TO TEACHER-PUPIL PLANNING

The present science program discusses the science activities for Grades VII, VIII and IX of the junior high school and is built

on the substructure of science understandings that are the outcome of elementary education in Grades I to VI.

This guide has been designed to aid teachers in making science instruction meaningful and effective. It contains an overview of the science program, suggests the underlying philosophy, proposes content in relation to important concepts, indicates essential experiences, and provides reading references.

The new Science Program is flexible and suggestive within the framework of the unit studies. Although the overall pattern of unit studies gives a suggestion of rigidity, it should be fully appreciated that the teacher has considerable freedom within the unit studies. In other words, while all the units listed in the overall chart on page 38 are to be studied from year to year, the activities in the detailed units of chapters 5, 6 and 7 are merely suggestive. In fact, it would be rather surprising to find teachers ticking and checking off all the suggested activities that have been proposed in the various unit study outlines. The content of this course should serve as a guide in making science vital and more operative in the lives of youth in their particular community.

Under the unit study method a problem may be carried on as outlined and should be enriched as time and interest warrant. The teacher should exercise initiative and resourcefulness in adapting the unit to a particular class situation and to the particular interest of the group.

ARTICULATION WITH SCIENCE IN ELEMENTARY AND SENIOR HIGH SCHOOL

Articulation of Content

There are three major areas of science study extending from the elementary grades into the junior and senior high school grades. (see chart on page 40.) These three areas are:

LIFE or LIVING THINGS
THE EARTH AND THE UNIVERSE
WORK, ENERGY, MACHINES AND MAN.

The chart on page 40 reveals that the junior high school studies are merely an extension and expansion of the elementary grade understandings connected with these three areas of our environment. It is expected that all children in elementary school will have had an opportunity to experience directly these areas of science study either in their Enterprises or in the Parallel Activities. The junior high school program has been designed on the assumption that these foundations have been laid. This is the basis of the philosophy of expanding concepts.

The new junior high school program forms a basis for the biological and physical science courses of the senior high school.

The study of LIFE or LIVING THINGS provides a suitable groundwork for Biology courses. The study of THE EARTH AND THE UNIVERSE is a foundation to a study of Geology. The study of WORK, ENERGY, MACHINES AND MAN is a good beginning for the study of Physics.

Articulation of Method

Since students have had experience with the enterprise technique in elementary school and with the problem-solving method in the social studies of Grades VII, VIII, IX, the science teacher in the junior high school should be able to use the unit method in science with comparative ease. Children should know how to handle themselves in committee and in individual work.

THE IMPORTANCE OF COMMITTEE WORK

This program has been organized on the basis of individual and group work in committees. Reading and report work, carefully directed by the teacher, is an important phase of the course.

Individual differences: It has long been known by both parents and teachers that children differ greatly, even in a given family, in their general ability, interests, and temperament. Despite this knowledge, our schools have continued for long under a pattern of mass instruction, completely ignoring the individual differences of the children in the total group. Little effort was made to adapt the program to the wide ranges in pupil capabilities.

Enrichment for the interested: This course provides for the fullest possible development of all youth in the field of general science. Pupils should have opportunities to experience this full development in harmony with their individual talents, their readiness to assume responsibility and their desire to cooperate with others.

Enrichment for the Very Bright

Teachers should ever be on the alert for the challenging assignment which the bright student desires. The suggested activities in the various unit study outlines represent an "average". Enrichment activities have been provided to meet the needs of the brighter students. These have been listed in the unit studies of Chapters 5, 6, 7, under the heading of SUGGESTED ENRICHMENT ACTIVITIES at the end of each unit. These activities should serve as a challenge to the highly interested and mentally alert child. They are not for "common consumption". Teachers should be prepared to add other additional exercises when and where the situation demands such further enrichment.

THE TEACHER STILL TEACHES

The teacher's function is to organize the unit studies, to teach certain formal lessons, to supervise experimental work, to direct

committee work, to sit in with group and individual discussions, and to assist in summing up student effort. The teacher may find that up to a maximum of fifty per cent of his time is devoted to direct teaching with the whole class listening and answering questions. The amount of time devoted to direct teaching will vary with the type of class, with their readiness to respond to unit study teaching, and with the number of grades in a room.

A very important function of the teacher is to strengthen student reports by summarizing topics with the class and possibly by writing outlines on the blackboard with the help of pupils. This procedure should answer the criticism that students do not achieve mastery or understanding of reports prepared by other students.

THE DEVELOPMENT OF SILENT READING ABILITY

Science is an important subject for developing the various reading skills which a capable student should acquire. The teacher must assume responsibility for developing such reading skills as the following:

1. **Reading for Comprehension:**
   for example, reading to discover how water power makes electricity, or, how an electric motor works.
2. **Reading to Find Out Facts and Information:**
   for example, reading to discover the names and sequence of Canada's time belts.
3. **Intelligent Skimming:**
   for example, reading to find methods of farming to prevent erosion.
4. **Reading to Increase Technical Vocabulary:**
   (not neglecting the spelling of new words): for example, reading to learn the names of the processes related to the concept of photosynthesis.

Growth in such reading skills will involve self-checking by the pupil (re-thinking the passage previously read). The teacher should make certain that the assigned material is at the level of the pupil's understanding. Success in the development of reading skills may be evaluated by suitable testing devices, either written tests or oral reports. Further suggestions related to reading skills may be found in the Literature and Social Studies-Language programs.

ORGANIZATION OF THE SCIENCE PROGRAM

This program is designed on an "expanding concepts" idea. By expanding or spiralled concepts is meant a continuity of experiences resulting from the ever-enlarging ideas gained by pupils in the study of their environment. These experiences take on an

ever-widening meaning as the learner matures and as his interests develop and change. The unit studies furnish a continuity of expanding ideas or concepts as the child progresses through the grades. Concepts such as "Man's Control of His Environment" and "The Adaptation of Life to the Environment" are repeated in divergent and more complex situations from year to year in order to be understood by the maturing child.

As boys and girls grow up in a world of living things their experience in the physical and biological phases of their environment widens. They find that man, living in the universe, learns to control his earth environment and the plants and animals therein. They discover that the earth's surface is changed by heat, cold, wind and rain. They see man harnessing different types of energy to suit his needs. These themes constitute the "threads" of science that run through the grade studies in such a way as to enlarge and broaden the child's understandings.

Figure on p. 16 illustrates the idea of expanding concepts or the extension of understandings that a child experiences when he thinks about the sun as a part of the universe. The simple understandings or direct experiences of pre-school years serve as a foundation for the work of the elementary school. The elementary grade school teacher broadens the base of understandings by seeing to it that the child's ideas will be expanded. His task is to so direct the child's science learnings that the junior high school teacher will in turn aid the child to expand and develop his previous understandings. As the child progresses through the grades, new concepts or ideas are acquired, and by the time the unit study work of the junior high school is completed, a solid foundation has been laid for the general or special science studies of the senior high school.

Under the scheme of expanding ideas, topics that appear both in the elementary and in the senior high school grades may also be dealt with at the junior high school level. It should be realized that this is to be expected under a spiralled or expanded plan of learning. In fact, this idea is not startling or particularly new. It has always applied in such subjects as mathematics, grammar, and even in the study of foreign languages. The main difference between this program and programs of the past is that there now exists a planned sequence of expanding ideas. No longer should anyone say that children should not learn the symbol for CO_2 in Grade IX because "this comes in Chemistry in Grade XI".

THE ENLARGEMENT OF IDEAS (EXPANDING CONCEPTS)

THE EXPANDING IDEA OF THE "SUN IN THE UNIVERSE"

PRE-GRADE I

The sun rises, sets, and is hot. The moon and stars are seen at night.

GRADE I:

The sun gives light and makes color. The sun seems to move across the sky.

GRADE II:

The child observes his shadow and other shadows. Length of shadows indicates time of day and year.

GRADE III:

The child can see by full moonlight. He learns four phases of the moon.

GRADE IV:

The child notes seasonal changes, also high and low sun. He learns that the earth spin causes day and night.

GRADE V:

The child learns about the Sun's Family or Solar System which includes the earth and the other Planets.

GRADE VI:

The sun is responsible for heat changes throughout the day and year. Heat causes wind. The earth's surface changes due to heat, wind, water, gravity.

GRADE VII:

The sun's heat on a spherical earth results in heat zones and vegetation belts on the earth. Man uses sunlight in his camera.

GRADE VIII:

The child learns about theories that try to explain the story of the "sun-system". Gravity is important on the earth and also out in space. Tides are caused by gravity and by a "throw-off" effect.

GRADE IX:

Solar energy really keeps things "going" on the earth. Photosynthesis is important in maintaining life on the earth. Telling time by the day, month, and year is related to the movement of heavenly bodies. Heavenly bodies align themselves and cause the eclipses.

It should now be plain that certain major areas of study in science carry through not only from grades VII to IX, but in actuality from grades I to IX and even beyond. In fact, these areas of study carry through into later life. The study of Living Things, of The Earth and The Universe, of Work, Energy, Machines and Man, do not necessarily stop when the student leaves school.

The overall pattern on page 38 shows the three major areas subdivided into six sections. These divisions constitute the scope or large areas, and these general themes or threads extend through all the grades. The aim of the total program is to assist the child to develop understandings, skills, abilities, habits, and attitudes in the field of science in those major areas of: "Living Things", "The Earth and the Universe", "Work, Energy, Machines and Man".

SUMMARY OF THE POINT OF VIEW IN THIS CHAPTER

In directing a science program that is based on an overall design of unit studies, it will be necessary for the teacher to use methods of instruction that emphasize group activity, committee work, teacher-pupil planning, direct experiences, excursions, experiments, reports, high standards of work, improved English expression, willingness of students to assume a share of responsibility in working with others, searching for information on the part of the student and varied reference materials.

This program cannot be handled under a plan which interprets science learning either in terms of pages to be covered in a text or a specially prepared manual, or in terms of activities to be checked off in a suggested outline of a unit study. Teachers must realize that science learning is a matter of developing science understandings, science skills and abilities, and scientific attitudes. Such outcomes can only be achieved if teachers start with the child where he happens to be, in regard to his immediate geographic locality, his own level of maturity or growth, and his own personal background in the field of science. It is of the utmost importance that science understandings be acquired at all grade levels, hence the urgent need for including essential science in the work of the elementary grades.

Science is the organized extension of knowledge about man and his environment. This new science program is characterized by a method of procedure called the scientific method. This problem-solving method is the method of democracy, and in life we meet it at every turn. It is the method of group-interaction with a goal or purpose in view.

There is no place for textbook reciting in this program. The unit study method stresses experiencing in an environment of things, life, and events. The classroom is to become a place for

group reading, doing, discussing, observing. The teacher should exploit the native curiosity of adolescent and pre-adolescent youth.

Apart from the method or technique of problem-solving, scientific knowledge is essential in our age of science. Scientific developments have created new jobs for millions. Our natural wealth has been partly developed and our wants have multiplied. Science is important in peace and war. Science has given us increased leisure, happiness, and comfort. In this world of science the educated individual must be trained to think scientifically in the solution of personal, group, national, and world problems.

This chapter constitutes an overview of the spirit or philosophy of the new science program. The keynote of this philosophy is the stress to be laid upon certain goals or outcomes which are to be dealt with in greater detail in the next chapter. In summary, science teaching aims to make use of the scientific method in the handling of certain unit studies. In this process of problem-solving, three important specific objectives will appear:

1. The interpretation of certain general ideas (understandings).
2. The development of certain physical and mental performances (skills, abilities, habits).
3. The formation of certain points of view (attitudes).

CHAPTER II

OBJECTIVES OF SCIENCE TEACHING

Many attempts have been made to define the aims of science education. In a world of rapid change the purpose of science teaching is to prepare youth to live well. Living well means to be healthy; to be a responsible citizen; to understand the world we live in; to appreciate the wonders of the world; to appreciate the use man makes of the gifts with which he has been provided. As life progresses from hour to hour and from year to year there are many scientific influences that direct and shape our lives. Science teaching aims to help people to adjust themselves to these scientific influences, and to utilize and improve the physical environment so as to live more richly and more wisely in a scientific world.

In addition science teaching aims to help people solve new problems that have arisen because of our scientific progress and our social development. Industry and science have given us the airplane, the automobile, the automatic telephone, and the refrigerator, but these advances have resulted in numerous shocking accidents, strikes, and unemployment. Research study in man's social problems must be attacked as seriously as research studies in biological and physical science.

THE FOUR GENERAL OBJECTIVES OF EDUCATION

When discussing the objectives or purposes of education, the whole matter may be summed up by saying that education should train people to think intelligently about their problems of individual and group living.

> "The ability to think reflectively and the disposition to do so in all the problem situations of life is an especially important educational objective. It is essential to adaptability . . ." (Quotation from *Science in General Education,* 1938).

What are these "problem situations" of life which call for "adaptability"? The answer to this question should tell us what the general objectives of education are. In our democratic way of living the individual is considered to be of supreme worth; therefore our educational system and our society should be prepared to develop the individual to his fullest possible extent. In other words, the main purpose of education is the development of the individual. The individual cannot live unto himself alone; he must grow up in group situations, and one of the most important groups to which he must adjust is the family. Again, since each individual must earn a living, he must be prepared for a job, and since he must live in large social groups that are organized for the common good, he must develop into a good citizen. Therefore, the four

functional or basic objectives of education are all related to the individual. They are:

A. Personal Development
B. Growth in Family Living
C. Growth Toward Competence in Citizenship
D. Occupational Preparation.

The Junior High School Handbook makes reference to these four functional aims of education. The Curriculum Guide for the Secondary Schools also considers these functional objectives in detail.

HOW SCIENCE CONTRIBUTES TO THE FOUR BROAD FUNCTIONAL OBJECTIVES OF EDUCATION

A. Personal Development: (The Individual as Such)

Science contributes to the personal development of the individual in five important areas, (1) *physical health,* (2) *intellectual achievement,* (3) *leisure-time activities,* (4) *personal habits,* (5) *personal attitudes.*

(1) *Physical health*: Science fosters a proper understanding of the scientific phases of sound physical health.

(2) *Intellectual achievement*: Science contributes to intellectual achievement by:
   a. Developing in the individual a curiosity about things which surround him.
   b. Developing the ability to speak intelligently about scientific progress.
   c. Developing the ability to compute accurately, using scientific measurement.
   d. Developing the ability to listen intelligently to addresses on scientific subjects.
   e. Developing the ability to read intelligently articles in magazines and other publications.

(3) *Leisure-time activities*: Science contributes toward the development of suitable recreational and leisure time activities by:
   a. Allowing the individual to take advantage of scientifically improved forms of recreation.
   b. Encouraging the individual to use leisure time wisely in a scientific world.

(4) *Personal habits*: Science contributes to the establishment of sound habits by:
   a. Encouraging the individual to exercise shrewd judgment as a consumer.
   b. Requiring the checking and re-checking of work at all times.

(5) *Personal attitudes*: Science contributes to the growth in suitable attitudes such as:

a. An appreciation for the painstaking and thorough work of scientists.

b. A respect for the law, order, and beauty of nature.

B. Growth in Family Living (The individual as a group member)

Science contributes to growth in family living by; (1) *assisting in establishing the home as a democratic institution,* (2) *helping to create conditions essential to successful family life,* (3) *enhancing opportunities for enjoyment at home, and* (4) *aiding the establishment of good relationships between the family on the one hand, and the neighbors and the community on the other.*

(1) *The home as a democratic institution*: Science instruction stresses group discussion and planning, thereby encouraging a give and take atmosphere in family relationships by permitting all members to express opinions regarding family problems.

(2) *Conditions essential to successful family life*: Science develops an understanding of the operation of scientific equipment and home conveniences.

(3) *Opportunities for enjoyment at home*: Science enhances the opportunities for enjoyment at home by making the individual aware of:

a. Ways of making the home more comfortable through the use of labor-saving devices.

b. The proper care and operation of appliances and machines in the home (e.g. radio, toaster, iron, movie projector).

(4) *Relationships between the family and the community*: Science improves these relationships by giving the individual an understanding of the need for such things as proper garbage disposal, supplies of pure water, and control of epidemics.

C. Growth Toward Competence in Citizenship (The individual as a community member)

Science assists people in becoming better citizens of their community, province, country, and the world. Studies in science contribute to growth in citizenship in six significant areas: (1) *historical background,* (2) *contemporary socio-scientific problems,* (3) *political action,* (4) *consumer competence,* (5) *democratic procedures,* (6) *attitudes toward world affairs.*

(1) *Historical background*: Science helps the individual acquire necessary insights into the historical background of contemporary science through a study of the contributions made by science heroes of the past.

(2) *Socio-scientific problems*: Individuals can make more intelligent decisions concerning legislation affected by science and technology when they understand the scientific processes involved. (e.g. legislation dealing with flood control, power dams, water supplies, conservation projects, irrigation, highway building).

(3) *Political Action*: A study of science should foster in the individual an attitude of respect for the opinion of others based upon a wilingness to weigh and assess facts. This attitude is valuable in political activities both during school years and in post-school life.

(4) *Consumer competence*: Science stresses the search for truth rather than the emotional acceptance of unscientific propaganda. This ability to distinguish truth from propaganda will help the individual to resist the emotional appeal of high pressure advertising. Science develops an appreciation of the need for the scientific development of natural resources. Through a study of science, individuals learn to become wise rather than wasteful consumers.

(5) *Democratic procedures*: Science fosters democratic attitudes and encourages democratic behavior by stressing cooperation of the individual as a member of the scientific world community.

(6) *Attitudes toward world affairs*: The study of science fosters a growth in loyalty to the principle of democracy at the world level by:

a. Making the individual aware of the need to improve unsatisfactory living conditions wherever they occur.

b. Creating a desire on the part of the individual to procure social justice for all by providing some measure of material comfort for the people of the world.

D. Occupational Preparation (The Individual as a producer)

Science contributes to the occupational preparation of the individual through: (1) *enhancing vocational opportunities,* (2) *encouraging the wise use of guidance services,* (3) *developing aptitudes and abilities.*

(1) *Vocational opportunities*: Many jobs require scientific knowledge and comprehension. A study of science will supply this knowledge and comprehension, thereby increasing the individual's vocational opportunities.

(2) *Guidance services*: To make intelligent use of guidance services the individual must be able to weigh evidence, consider his own abilities and aptitudes objectively and come to some tentative conclusion regarding his vocation. In other words, he must apply the scientific method in choosing his life work.

A study of science will assist the individual in becoming competent in the use of the scientific method and its application to a wide variety of situations.

(3) *Developing aptitudes and abilities*: In pursuing scientific studies the individual may discover aptitudes and develop abilities which may lead to a wise selection of his life work.

In the various unit studies will be found the specific objectives which children should achieve in order that they will ultimately attain the scientific phases of the aforegoing broad or functional objectives.

THE THREE GROUPS OF SPECIFIC OBJECTIVES OF JUNIOR HIGH SCHOOL SCIENCE TEACHING

More important for the implementation of this program are the specific objectives which constitute the outcome of the special unit studies listed in the overall chart on page 38. As the teacher views each child as a person, growing up in a family, heading for citizenship, and preparing for a job, he should at the same time consider the means to these ends. As the particular unit studies are carried out, the teacher asks himself these questions:

What special aims am I trying to achieve?

What facts and information should students acquire?

What general ideas will be gathered from these facts and information?

What specific skills, abilities and habits should be developed?

What attitudes are the children building up during the course of the unit?

Three kinds of specific behavior are expected of pupils as they pursue their unit studies. They are: (A) growth in science understanding, (B) mastery of skills, abilities, and habits, (C) the development of appropriate attitudes. These three objectives are shown to the left in chart on p. 25. The analysis of these three objectives is shown to the right.

The specific objectives, which are the direct outcome of the unit studies in Grades VII, VIII, and IX, may be defined as follows:

A. Understandings

An understanding is a general conclusion (stated or sensed) which is arrived at as a result of such experiences as specific problems, information, experiments, etc.

Example of how an understanding is arrived at: (Observations and experiments about air pressure). Trees bend or break in a wind; sailing ships move because of the force of the wind; cars are designed to lessen wind resistance; moving air operates windmills and wind-chargers; air supports planes and parachutes; an experiment with an inverted tumbler of water

covered with paper shows that air exerts a lifting effect; a barometer actually measures the pressure of air; the application of air pressure is found when water is raised from a well (lift-pump). Understanding (or general conclusion), in words: Air exerts pressure on all objects with which it comes in contact. This understanding is often called a generalization.

B. Skills, Abilities, and Habits:

1. *Skills*: A skill is a physical or mental act that we have learned to do reasonably well.
   Examples of a physical skill: Bending glass tubing; setting up pulleys or other experimental material.
   Example of a mental skill: Estimating the normal barometric pressure when the altitude is known. (e.g. Edmonton's altitude is approximately 2,000 feet. What is the normal barometric pressure?).

2. *Abilities*: An ability is the capacity to apply a skill or an idea. Example: Applying the scientific method in solving one's own problems.

3. *Habits*: A habit is a way of doing, acting, or thinking, which becomes so easy through practice that it requires little or no conscious effort. Example: Keeping a neat science notebook: consulting authorities to prove a point; using a dictionary all through life.

C. Attitudes:

An attitude is a way of reacting with feeling towards persons, things, and ideas. Example: Keeping an open mind on questions; learning to keep cheerful when things go wrong; cooperating enthusiastically in a group; displaying good will toward others; having faith and confidence in nature's laws.

To clarify further the specific aims of science instruction, the analysis of the three specific objectives (see page 25) will now be explained more fully.

A. Kinds of pupil experience which should assist him to grow in science understandings:

1. How the acquisition and use of specific scientific facts lead to a science understanding:

   Science information and science facts become significant only when their practical applications are made evident. Students should learn to use facts intelligently in all phases of their daily living. The science program provides an abundance of factual knowledge in many problem-solving situations. Facts should be relevant or meaningful

ANALYSIS OF THE THREE SPECIFIC OBJECTIVES IN SCIENCE TEACHING

THE THREE TYPES OF SPECIFIC OBJECTIVES	BREAKDOWN OF THE THREE TYPES OF SPECIFIC OBJECTIVE
A. UNDERSTANDINGS General ideas resulting from the unit studies in science.	Science understandings are developed in the following way: 1. Acquiring and using specific scientific facts 2. Observing the natural environment 3. Using experimental evidence 4. Observing and studying interrelationships among scientific phenomena 5. Applying general scientific principles. (This may clarify a previously acquired understanding or may lead to new and broader understandings.)
B. SKILLS, ABILITIES AND HABITS Capacities that are developed during the process of science investigation.	Skills, abilities, and habits are developed in the following areas: 1. Graphic arts (charts, diagrams, drawings, etc.) 2. Communication (oral and written expression) 3. Reading 4. Organization and arrangement of materials 5. Use of the scientific method 6. Experimental work 7. Social relationships 8. Mechanics 9. Mathematics
C. ATTITUDES Behavior traits (how students feel and act) as developed during Science Studies.	1. Self respect 2. Creativeness 3. Scientific attitude 4. Cooperation 5. Responsibility 6. Social concern 7. Reverence

in order to be of significant value. For example, it is a fact that water freezes at 32° Fahrenheit. A knowledge of this fact is of little importance unless it carries over into life. It is the relevance of this fact to the possible freezing of a large portion of our Alberta wheat crop, or to the freezing of plants and flowers in our home gardens, that make the fact important to us. The thermometer outside our window determines whether or not we shall spend hours covering plants against a coming frost, or whether the fruit losses in parts of California will raise the cost of fruit imported into Alberta. On the other hand, the freezing of water in a pond or in a refrigerator is a source of satisfaction.

From the intelligent interpretation of the fact cited above, we may develop an understanding such as the following: The physical change that takes place when water freezes may be a source of either annoyance or satisfaction.

2. How the student's observation of the natural environment may lead to science understandings:

The natural environment provides many examples of experiences that may lead to general ideas or understandings in science. Pupils in rural and urban areas observe that, in places where the soil is loose and bare, the wind and the water transport it readily and may even pile it into mounds. On the other hand, where the soil is protected by leaf mold or other material, this action does not occur. As a result of several such observations, the student may conclude that soil erosion may be prevented by keeping the soil covered.

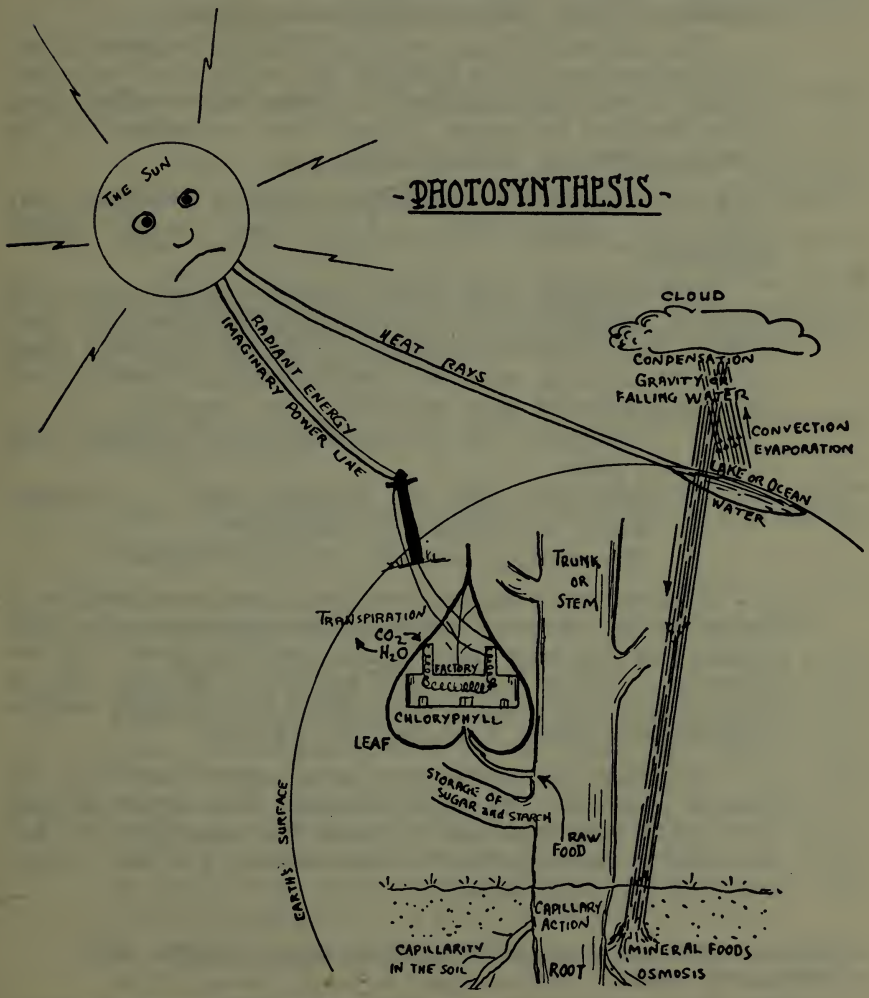
3. How the use of experimental evidence assists in the development of science understandings:

Experimental work in the science laboratory provides particular experiences which may guide subsequent action. These particular experiences should result in a general conclusion or understanding which carries over into life situations.

The laboratory experiment with brass ball and ring, which illustrates the expansion of metals when heated, helps to explain why a furnace thermostat automatically controls the heat in our homes. Or, the experiments on the evaporation of alcohol or water explain why perspiration in midsummer helps to keep us cool (regulates our body temperature). The student might then arrive at such general ideas as: Solids usually expand when heated and contract when cooled, and Evaporation takes away (requires) heat. Note: Laboratory experiments should be supplemented with applied readings from the texts.

4. How the interrelationship among many science factors (cause-and-effect) may develop understandings:

The theme of interrelationships is very common in junior high school science. The total relationship of ideas about a science topic often constitutes a pattern that is difficult to express in words. An actual illustration of a Grade VIII student's attempt to explain the several processes or relationships involved in an understanding of photosynthesis is shown in the figure below:



A GRADE VIII STUDENT'S UNDERSTANDING OF PHOTOSYNTHESIS

The verbal statement of the understanding in the student's illustration on page 27 might be expressed as follows: Photosynthesis, or the plant making of food with the aid of sunlight, is a very involved process.

5. Growth in *Appreciations* and *Understandings* are interdependent. Radio, television, and the movies are very common forms of entertainment today. The simple experiment on the magnetic effect of an electric current, performed by Michael Faraday about a century ago, made these types of modern recreation possible.

   Again, a scientific appreciation of the beauty of a rainbow involves an understanding of the reflection and refraction of light inside individual raindrops.

   The understandings resulting from such appreciations as the above, are: The Scientist has contributed very generously to our high standard of living and comfort; and, Color displays in nature, in any form, are caused by the breaking down of "white" light.

6. How the application of general scientific principles may clarify an understanding and contribute to new understandings:

   The principle that energy can be changed from one form to another is an understanding expressed in short form. The principle is applied in the hydroelectric plant at Seebe, Alberta, and new understandings develop from the application of this principle. For example:

   Electricity can be transmitted or "carried" over a wire.

   Electricity can be "stepped up" or "stepped down" by means of transformers.

   Electricity is paid for in units of "power".

   The science program contains numerous examples of principles which are of value and meaning to us in our daily living. A fine wire carrying an electric current may become hot. Under control in a toaster, all is well. But in the attic of our homes, or on the top of a high voltage transmission tower, it can cost us our lives.

   The laws of science are often simple but they are always universal. An object dropped from above ground, or a plane that runs out of fuel in the upper air, will fall to earth in Russia, Alberta, everywhere. The law of gravity is universally true.

B. Kinds of experience which should assist the pupil to develop skills, abilities and habits:

1. How graphic and artistic skills and abilities can be developed in science work:

These may be practiced in such activities as the following: making friezes, graphs, charts, maps, and diagrams.

2. How communicative skills and abilities may be developed in science work:

   These may be developed through the following avenues: reading, writing, spelling, listening, reporting, summarizing, discussing, debating and various library habits.

3. How mechanical skills and abilities are developed in science studies:

   These are used in laboratory work, in improvising apparatus, in constructing models, and in servicing and repairing equipment.

4. How social skills and abilities are developed in science studies:

   These may be developed by providing opportunities to display courtesy, tolerance, and cooperation in group work.

5. How reasoning ability may be developed in science work:

   This ability should develop as the child makes cause-and-effect inferences, proposes hypotheses or suggestions in unit studies, and performs computations in problems dealing with simple machines.

6. How students may grow in the ability to organize ideas and materials:

   This ability may be developed in the making of collections, in preparing oral reports, and in writing a paragraph or an essay.

7. How science helps students to develop the ability to use the scientific method in the classroom and in later life:

   Many of our great social advances are credited to the scientist and to the problem-solving method. The Panama Canal was made possible by scientists combatting the mosquito. Modern sanitation in our towns and cities depends on scientific methods of water purification and the social control measures set up by our provincial department of health. The method of investigating irrigation and conservation problems is an example of the scientific method used in cooperative social undertakings to bring greater comfort and happiness to a greater number of people.

   The scientific method of clear thinking is characterized by seven stages or steps as shown below. (Note: These steps will become clear when the Unit Study Method is discussed in detail in Chapter 4.).

THE SEVEN STEPS OF THE SCIENTIFIC METHOD

1. Sensing or recognizing the problem
2. Defining or limiting the problem
3. Gathering data pertinent to the problem
4. Proposing hypotheses to solve the problem
5. Finding best hypothesis to solve the problem
6. Reaching conclusions to the problem
7. Applying conclusions to new problems

8. How the habit of leading and following may be developed in science work:

This habit is really a social skill. The person who must dominate and lead at all times may become very unpopular. Various group situations should permit each individual to follow as well as lead.

C. Kinds of Pupil experiences which should assist him to develop desirable attitudes as a result of self-study and group work in science:

1. How growth in self respect may be developed in science study:

A student grows in self-respect as he learns to perform his duties willingly and to live up to his highest knowledge of what is right; in other words, he must acquire a set of values or standards of behavior and be reasonably satisfied with his efforts to act in accordance with them. No one succeeds fully in performing his duty or acting in harmony with his highest knowledge of what is right, but if he falls far short of his standards he loses his self-respect. However, if he attempts sincerely and continuously to act properly, he will develop self-respect. The essential purpose so far as the school is concerned is to foster a strong desire in the pupil to act in a manner conducive to the growth of self-respect so that ultimately his behavior will reflect an inner harmony or satisfaction because he enjoys doing what is right.

This science program will bring the individual face-to-face with tasks that will challenge him and permit him to grow in this attitude of self-respect. He will enjoy being punctual because such behavior is right action in a group situation; he will enjoy concentrating on a task because he is thereby contributing to the solution of the problem in hand; he will enjoy persevering because he is anxious to see a task through by reaching certain conclusions; he will enjoy being sincere, honest, and trustworthy because he has played the rules of the game by doing a full share of the problem study.

2. How science activities may contribute to an attitude of creativeness:

Students should be given opportunities for original self-expression in essays, drawings, charts, friezes, construction work, scrap books, and notebook work.

Interest and curiosity in science may lead directly to hobby or avocational pursuits. In a world where leisure time is increasing, spare-time activities are becoming more and more essential. Fascinating and challenging interests such as reading scientific books and periodicals, using photography as a hobby, working with a home-chemistry laboratory, operating a public address system, and studying television, may lead to a life-time hobby or serve as occupational preparation.

3. How the unit studies may help to develop an attitude toward the scientific method:

As the unit studies proceed, the student should appreciate the fact that the scientific method (see page 30) is an effective way to solve a problem. In the course of the unit he should learn the importance of consulting reliable authorities. He should grow in the use of good judgment by basing his decisions on the scientific method of thinking. In this way he should learn to avoid prejudice, and to evaluate properly what he reads, sees, and hears.

The attitude of open-mindedness prevents us from making sweeping generalizations from insufficient data. Who knows if we will ever be able to reach the moon or Mars?

If students are trained to think critically they will learn to view all sides of a question before coming to conclusions. It is unscientific to say that the discovery of atomic energy is either totally harmful or totally beneficial. It is equally unscientific to say that students do not spell as well as their fathers, unless we get the facts to prove the statement.

The scientific method should be used to a greater extent in dealing with many of our social and economic problems in the world of today. The necessity of flood control becomes a social problem on a national scale that should be approached in a scientific manner.

Students should likewise develop an attitude of pride in the achievement of famous scientists and for the way in which man has learned to utilize and control nature's bounteous gifts. Youth should know that the efforts of the research worker, toiling away today in his laboratory, will contribute to Canada's future progress. The scientist uses the scientific method in seeking cures for our ills, in experimenting with new forms of energy for our machines, in trying out new labor-saving devices, and in searching for ways to extend the life span.

4. How students develop an attitude of cooperation in their science studies:

   As students work together in group situations they should develop an attitude of cooperation. This implies the willingness to get along with others, to respect their rights and viewpoints. They should learn to contribute their share enthusiastically and cheerfully to the problem in hand. In adult life, peaceful living with our local, national and world neighbors is but an extension of the same principle as that experienced in group activity in the classroom.

5. How the science studies will assist students to develop an attitude of responsibility:

   In the process of democratic classroom living, each individual must recognize the need for group regulations comparable to regulations of our adult society. The individual has responsibilties to the group as well as to himself. Each individual must learn "play the game" and to be sincere, trustworthy, and dependable in working on a problem. He should learn to complete an assigned task and to be punctual by getting it in on time. As an adult citizen, he will later be expected to contribute his share to the improvement of his community and to our Canadian way of life.

6. How unit studies should help students to grow in an attitude of social concern:

   Students should learn to adjust their personal desires to the welfare of the group. This involves a display of good-will toward others and the development of mutual friendliness through socialized group work.

   Science lends itself well to the development of a social concern for the benefits of peace and destructiveness of war. Our permanent army, navy, and airforce are highly mechanized and are built on a foundation of scientific achievement and scientific research. However, boys and girls must be made to realize the utter wastefulness of war, even to the victors. The teachers should endeavor to instil in the minds of youth the joy of peaceful living and the satisfaction resulting from a Christian and a democratic way of life at the local and the world level.

7. How an attitude of reverence may be developed in science: Reverence is a feeling of deep respect and admiration inspired by:
   (a) the order and immensity of the universe
   (b) the microscopic, or the "infinitely small"
   (c) eternal changelessness, and eternal change
   (d) nature's complexity, and man's progress in making predictions

(e) the beauties of nature
(f) the many forms of energy in nature
(g) the interaction of nature's forces
(h) the infinite forms of living and non-living things

Reverence implies a recognition of the inviolability of nature's laws which develops in us a faith and confidence in the natural order of things. The way in which "nature" causes life forms to be dependent on non-life materials is cause for wonder. The fortunate provision of nature that water contracts when it cools down to a certain temperature and then begins to expand, makes it possible for aquatic life to live during the winter. The sun supports all life on the earth. We could not live without the protective air blanket that surrounds the earth. Gravitational forces hold the earth, sun, moon, planets, and stars in their respective paths. Beneficient "nature" provides life cycles, nitrogen cycles, carbon cycles. The continuity of life, the energy of the atom, life in the cell, and the unity of the of the universe—all these should arouse admiration in the student.

Great scientists and great religious teachers recognize that the deepest beauty in the world of nature lies in its order and meaning. The function of the school is to ensure that the appreciations of science are not at variance with religious teachings. Science instruction should strengthen religious convictions. A proper understanding of cause and effect in science should counteract the idea of "blind chance", or "luck".

Science understandings lead to the development of an attitude of reverence. The importance of the general idea that "Time is endless" may lead the students to establish such a strong appreciation for this generalization, that he will ultimately develop a strengthening of his religious convictions and develop an idealistic way of thinking about the relation of his life to the universe as a whole. In considering the natural splendor of the Grand Canyon of the Colorado, Crater Lake in Oregon, Lake Louise in the Alberta Rockies, the Bad Lands of the Red Deer River Valley, the student will be impressed with the infinity of time.

Students will develop admiration for the marvels of life forms such as: the skilful spider weaving its intricate and geometrical web, the gorgeous coloring of the male pheasant, and the remarkable transformation from caterpillar to moth.

Student admiration will be shown for the infinite variety of hexagonal forms in snow crystals, the fern forest and frost scenes on a window pane in winter, the remarkable colors of a western prairie sunset, and the vacillating hues of the aurora borealis.

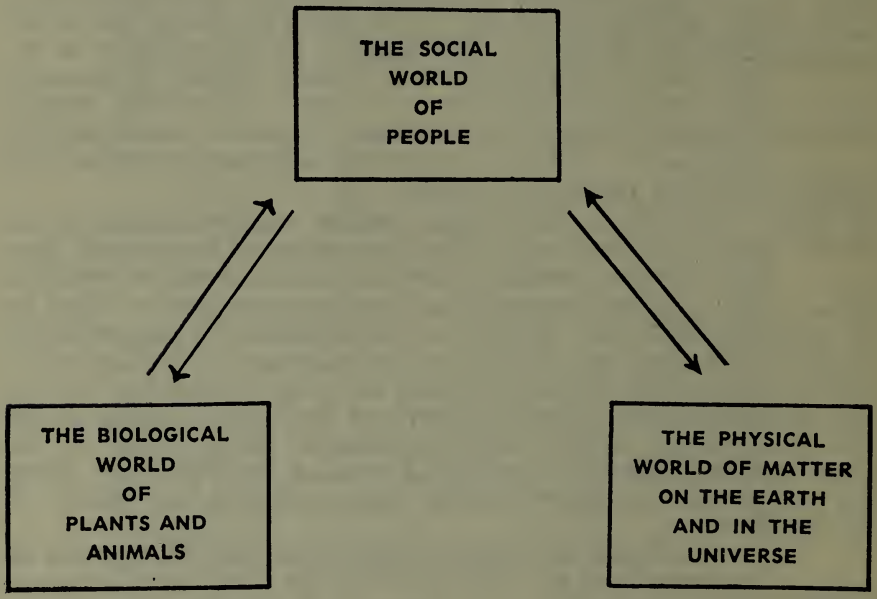
CHAPTER III

ORGANIZATION OF THE SCIENCE PROGRAM

THE GENERAL THEME OF INTERRELATIONSHIP

Coursing through the entire junior high school science program is the theme of the interrelationship between living and non-living things in a universe of an unknown amount of energy. Man has harnessed this energy to a remarkable degree, but future developments and potentialities are by no means final. The energy of lifeless or inert matter knows no bounds. The teacher and pupils should endeavor to detect this single theme of interrelationship running throughout the entire pattern of unit studies. Thus the total environment, physical, biological, and social, becomes the stage setting for the various unit studies. The following chart should help to make this interrelationship clear.

THE CONCEPT OF INTERRELATIONSHIPS BETWEEN LIVING AND NON-LIVING THINGS.



BASIC PRINCIPLES OF DESIGN IN THE JUNIOR HIGH SCHOOL SCIENCE PROGRAM

In planning the science program, certain guiding principles are fundamental. They are used as criteria for the organization and selection of materials for the course. In order to have a proper appreciation of the framework or structure of the program these principles are now outlined.

THE PRINCIPLE OF LARGE AREAS OF STUDY

The course is organized around certain large areas of our biological and physical environment. These Areas of Science Study are found to the left of the overall chart, page 38, and are often referred to as the *scope* of the program. These major areas are three in number, namely: Life, The Earth and the Universe, Work-Energy-Machine-Man. The overall chart shows these three areas subdivided into six major divisions of science study: Variety of Life, Adaptation and Interdependence, Space and Time, Change, Man's Control of His Environment, and Man's Use of Magnetism and Electricity. The grade-to-grade treatment of these various areas of the scope are handled in a series of unit studies, and not under a compartmentalized subject matter treatment of physics, biology, and chemistry, nor under a text-book topical plan. The "scope" is really the "what" of the course.

THE PRINCIPLE OF PROGRESSION OR EXPANDING CONCEPTS

The course is so planned that students will experience a progression of difficulty as their understandings of the scope items are expended, according to increasing maturity and growth from Grades VII to IX. This progression or extension of treatment is often called the *sequence*. The "sequence" is really the "when" of the program.

THE PRINCIPLE OF UNIT METHOD

The course must be handled by the unit-study method throughout. Each section of the overall chart constitutes a unit, which will require approximately six weeks to complete. There are eighteen units of study in the total junior high school course.

THE PRINCIPLE OF ANALYSIS

Each of the eighteen units of the junior high school program has been outlined in order to show how the problem-in-hand might be analysed into a variety of activities to allow for individual differences of pupils in any given class or grade.

THE PRINCIPLE OF DIRECTED GROUP PLANNING

Planning for the school day, month, or year should never be a "laissez-faire" matter. The unit method demands advance preparation. The success of a unit study depends to a considerable degree on adequate planning by the teacher and on having appropriate materials available.

Each unit requires cooperative group planning between the teacher and the pupils. Progressive revision will take place as the unit develops. Finally, ideas are proposed to close off the unit. The teacher should plan to evaluate total pupil growth from the start of the unit. (See Chapter 8).

In selecting topics for study in the various units, the teacher will be directed by ideas and materials in this Curriculum Guide. This guide is the course of study in science. It therefore takes precedence over the primary reference or other texts.

At all times the teacher must realize his responsibility for outlining, directing, controlling, and summing up the

unit. He must be aware of how units and parts of units are to be subdivided to allow for group study and individual activity. The teacher must likewise decide which topics he must handle himself, e.g. Hybrid studies, Structure of Matter.

THE PRINCIPLE OF BROAD OUTCOMES

This science program provides for the achievement of broad outcomes as contrasted with the single and narrow outcome of traditional science teaching which emphasized only the mastery of isolated facts. No one will dispute the fact that the acquisition of definite and well-ordered information is a valuable outcome of learning, but it should be remembered that the development of good habits of thinking, of sound attitudes and appreciations, and of general understandings are at least of equal concern.

It is essential that adequate and exact science information be included in the program. The unit method merely places the acquisition of factual information secondary to the process of acquiring it. Furthermore, the unit method provides for the development of ability in the use of the scientific method with its related outcomes of learning, skills, abilities, and appreciations.

THE PRINCIPLE OF THE CONTINUOUS GROWTH OF THE LEARNER

The child's learning must be continuous. The units are arranged in a progressive and continuous sequence through the grades. The earlier units are generally simpler and more direct than the later one because students in Grade IX have had richer experiences and greater maturity than those in Grade VII.

THE OVERALL PATTERN OF UNIT STUDIES

The overall pattern of unit studies for each of the junior high school grades is shown in the chart on page 38. It consists of six units or major areas of scope in each of the three grades. The progression of the units through the grades is shown in each of the rectangular spaces under each grade heading.

It is felt that each of the units contains significant content, the study of which will result in the attainment of the specific and general objectives of science. The content material should be appropriate to the level of understanding of junior high school pupils and should challenge their interest. Every attempt has been made to relate the content material to the present living of the students and their experiences in an Alberta environment. The principle of "varied learning activities" has been kept to the forefront throughout the unit studies.

It should be apparent that experiments help the students to understand basic principles of science. Wherever teachers and students can use experiments to clarify thinking, they should do so. In order to assist the teacher to pick out the suggested experiments in the unit studies, they are indicated by placing the word "EXPERIMENT" in capital letters. This is done so that the teacher can quickly recognize these experiments and make necessary preparations for them.

From fifteen to thirty experiments should be planned for each of the junior high school grades. An attempt has been made to maintain a balance in the total number of experiments to be performed from grade to grade. The industrious teacher may change the number of experiments as he sees fit according to his particular class group.

THIS PROGRAM IS BUILT ON THE ELEMENTARY SCHOOL SCIENCE FOUNDATION

It is expected that elementary grade pupils will have developed certain general understandings, skills and abilities, and attitudes in connection with their studies of Living Things, The Earth and the Unverse, and Energy and Machines. The overall chart for junior high school science makes it apparent that the major areas of science study in junior high school articulate well with, and form an extension of, elementary school science learnings. The chart on page 40 shows the articulation between the elementary and junior high school science programs.

THE SCOPE AND SEQUENCE OF THE JUNIOR HIGH SCHOOL SCIENCE PROGRAM

The six items of the scope are an extension of the science studies of the elementary grades. The "scope" contains the areas of study, and the "sequence" indicates the order and development of the "scope" through the grades. This relationship is shown very simply in the chart below.

GRADE SEQUENCE

SCIENCE SCOPE

SCOPE AND SEQUENCE CHART OF UNIT STUDIES IN JUNIOR HIGH SCHOOL GENERAL SCIENCE

SCOPE: AREAS OF SCIENCE STUDY			SEQUENCE: PROGRESSIVE TREATMENT OF THE AREAS OF SCIENCE STUDY THROUGH THE GRADES:		
	The Three Major Areas of Science Study	The Six Sub-Areas of Science Studies	GRADE VII UNITS	GRADE VIII UNITS	GRADE IX UNITS
	A: LIFE	1. VARIETY OF LIFE: There are many forms of life.	VII-1: ANIMALS: A BRIEF STUDY AND SIMPLE CLASSIFICATION.	VIII-1: PLANTS: A BRIEF STUDY SIMPLE CLASSIFICATION.	IX-1: PLANTS AND ANIMALS BASIC TO ALBERTA'S AGRICULTURE.
		2. ADAPTATION AND INTERDEPENDENCE: Life depends on, and adjusts to, living and non-living things.	VII-2: LIVING THINGS ARE ADAPTED TO THEIR ENVIRONMENT FOR PROTECTION AND FOOD-SEEKING.	VIII-2: INTERDEPENDENCE OF "LIFE-AND-LIFE" AND OF "LIFE-AND-NON-LIFE"	IX-2: NATURAL AND ARTIFICIAL IMPROVEMENT OF ECONOMIC PLANTS AND ANIMALS.
	B: THE EARTH AND THE UNIVERSE	3. SPACE AND TIME: Space is vast and time is endless.	VII-3: BEYOND OUR SOLAR SYSTEM.	VIII-3: WITHIN OUR SOLAR SYSTEM.	IX-3: THE EARTH'S MOVEMENTS AND HOW THEY AFFECT US.
		4. CHANGE: The Earth's surface is being continually altered.	VII-4: THE STORY OF THE EARTH'S FORMATION.	VIII-4: THE EARTH'S "COVER": WEATHER AND EROSION.	IX-4: CONSERVATION OF THE EARTH'S RESOURCES.
	C: WORK, ENERGY, MACHINES, AND MAN	5. MAN'S CONTROL OF HIS ENVIRONMENT: Man is inventive and scientific.	VII-5: IDENTIFYING SIMPLE MACHINES.	VIII-5: MAN'S USE OF ENERGY.	IX-5: MACHINES AND THEIR SOCIAL IMPLICATIONS.
		6. MAN'S USE OF MAGNETISM AND ELECTRICITY: Man is an experimenter in the field of electricity.	VII-6: MAGNETS AND THEIR USES.	VIII-6: PRODUCTION OF ELECTRICITY AND ITS DISTRIBUTION IN THE HOMES.	IX-6: ELECTRICITY IN OUR DAILY LIVING.

SUBJECT AREAS INCLUDED IN THE SCOPE AND SEQUENCE OF UNIT STUDIES IN JUNIOR HIGH SCHOOL GENERAL SCIENCE

PROGRESSIVE TREATMENT OF THE AREAS OF SCIENCE STUDY THROUGH THE GRADES (Sequence)					
AREAS OF SCIENCE STUDY (Scope)	THE THREE MAJOR DIVISIONS OF SCIENCE STUDY	Subdivisions of Science Studies	GRADE VII UNITS	GRADE VIII UNITS	GRADE IX UNITS
	A: LIFE.	1. VARIETY OF LIFE: There are many forms of life.	VII-1: BIOLOGY	VIII-1: BIOLOGY	IX-1: ECONOMIC AGRICULTURE
		2. ADAPTATIONS AND INTERDEPENDENCE: Life depends on, and adjusts to,living and non-living things.	VII-2: BIOLOGY	VIII-2: BIOLOGY	IX-2: BIOLOGY
	B: THE EARTH AND THE UNIVERSE.	3. SPACE AND TIME: Space is vast and time is endless.	VII-3: ASTRONOMY	VIII-3: ASTRONOMY	IX-3: EARTH SCIENCE
		4. CHANGE: The earth's surface is being continually altered.	VII-4: GEOLOGY	VIII-4: GEOLOGY	IX-4: CONSERVATION
	C: WORK, ENERGY, MACHINES, AND MAN.	5. MAN'S CONTROL OF HIS ENVIRONMENT: Man is inventive and scientific.	VII-5: PHYSICS	VIII-5: PHYSICS	IX-5: SOCIO-PHYSICAL SCIENCE
		6. MAN'S USE OF MAGNETISM AND ELECTRICITY: Man is an experimenter in the field of electricity.	VII-6: PHYSICS	VIII-6: PHYSICS	IX-6: SOCIO-PHYSICS

SCOPE

SCIENCE

ARTICULATION BETWEEN THE ELEMENTARY, JUNIOR HIGH SCHOOL AND SENIOR HIGH SCHOOL SCIENCE PROGRAMS

SCHOOL GRADES		
ELEMENTARY	JUNIOR HIGH	SENIOR HIGH
I, II, III, IV, V, VI	VII, VIII, IX	X, XI, XII
1. Living Things	1. Life	1. Biology
2. Earth and the Universe	2. Earth and the Universe	2. Physical Science
3. Energy and Machines	3. Work, Energy, Machines and Man	3. Physical Science

Six Areas of Scope

1. Variety of Life
2. Adaptation and Interdependence
3. Space and Time
4. Change
5. Man's Control of His Environment
6. Man's Use of Magnetism and Electricity

The chart on page 40 shows that these six areas are grouped under three headings comparable to areas of study in the elementary school grades. These grouped divisions are:

A. Life
B. The Earth and the Universe
C. Work, Energy, Machines, and Man

TIME ALLOTMENT TO GENERAL SCIENCE IN THE JUNIOR HIGH SCHOOL

In many schools, mathematics and science will be taught by the same teacher. These two fields may be correlated or interrelated. In the junior high school grades the time allotment to mathematics and science combined is eight to twelve periods per week. These periods are to be set up in the daily time-table under a system of block scheduling. The mathematics-science block may be considered a unit of the schedule. Science will receive from four to six periods per week and mathematics four to six periods per week.

In the broad field or area of General Science, pupils will be expected to devote time to reading, writing, and spelling skills in their science studies. In fact, teachers should spend the equivalent of one science period per week for attention to these correlated skills.

It should be noted that the time devoted to science is slightly in excess of that found in the previous science program.

THE CYCLING-PLAN FOR COMBINED GRADES VII AND VIII

In Alberta schools, enrolments are often so small and the teacher load so varied and great, that a certain amount of cycling of the program may be necessary. In the larger city and town schools it is preferable not to cycle any of the course content. However, where Grades VII and VIII are found together in one classroom, these two grades may be grouped and their programs cycled. That is to say, the sequence of studies in Grades VII and VIII is covered in two years. Grade IX is not to be cycled with other junior high school grades.

The cycling scheme may be made clear by referring to the chart on page 38 and to the cycle tables below:

Cycle A: 1952-53 (Combined Grades VII and VIII)	Cycle B: 1951-52 (Combined Grades VII and VIII)
Units: VII-1	Units: VIII-1
VII-2	VIII-2
VII-3	VIII-3
VII-4	VIII-4
VII-5	VII-6
VIII-5	VIII-6

It will be noted that the units on "Identifying Simple Machines" (VII-5) and "Man's Use of Energy" (VIII-5) must both be taken in any one year because foundation learning acquired in the grade VII unit is required for the proper understanding of the Grade VIII unit. In other words, these two units cannot be cycled in the true sense of the term. The same argument for non-cycling applies to the units on "Magnets and Their Uses" (VII-6) and "Production of Electricity and Its Distribution in the Home" (VIII-6). Hence these units must also be taken together in any one year.

THE SCIENCE PROGRAM IS NOT RIGIDLY PRESCRIPTIVE

This general science program is designed to permit each student or group of students to develop according to individual talent and group interests. The actual science content for each unit will vary from group to group and with individuals in class groups. The interests, maturity or growth level, and the background of experience of the students are different in every classroom. The school location in each of the geographical divisions of the province and the season of the year will also affect the treatment of the unit studies. Teachers know that the students' experiences and interests will vary widely depending upon whether or not they live in rural or urban areas, or in prairie, parkland, bush, or mountain regions of Alberta. Children reared in a forested region around Fort Vermilion will have different experiences from those who grow up in the sugar beet section around Raymond or Magrath. This marked difference in the student's environment is bound to have an effect on all the unit studies but especially on those units found under divisions A and C of the scope (see chart, page 38).

The course purposely avoids rigidity in the details of the units. The major understandings, skills, abilities, and attitudes, representing desirable outcomes that should result from the particular unit, have been stated in Chapters 5, 6 and 7. A good formula regarding the suggested activities to remember at all times is: "Adapt, but do not adopt".

Flexibility: The overall plan is considered necessary in this program in order to provide logic to the course and to guarantee that the main areas of science are not overlooked.

The broad areas of our biological and physical world have been set out so as to provide a wide range of science experiences as the

child progresses through the junior high school grades. Whatever activities the teacher and pupils finally select, there should always be a rich variety of learnings. It is not intended that any or all of the suggested activities be undertaken. If the teacher can suggest better and more profitable activities than those proposed, he should by all means incorporate them into the unit being studied. It is contrary to the spirit of this course to apply a "coverage" principle in working with the unit studies.

SIX UNITS TO BE COVERED IN A SCHOOL YEAR

The overall plan (chart, page 38), is designed on the basis of a unit of study covering a period of about six weeks, but this time period or interval is not to be considered as a rigid requirement. Different teachers will spend varying amounts of time on the study of a particular unit. The amount of time distributed among the various possible activities will vary with the interests of rural, village, town and city children. The teacher should at least make an attempt to adhere to the suggested time allotment for each unit study. It may be found convenient to vary the order of the units from that set out in the overall chart for any given year.

The teacher must recognize that throughout the scope and sequence organization, there should develop a common core of general understandings, abilities, skills and attitudes. These latter outcomes constitute essential knowledge for all students. These common learnings should become a significant part of the students' future living as citizens of Alberta and of Canada.

TRADITIONAL CONTENT OF GENERAL SCIENCE PROGRAMS

The overall pattern does not ignore important content in science. It is felt that students as they proceed with their unit studies will in many instances become familiar with more content than in the past. The old science content is not overlooked — it is merely set out in a new pattern and handled by a new technique. The various units do not deal specifically with the traditional topics of Air, Water, Soil, Heat, Light, Sound, Transportation and Communication. A careful examination of the outlines of the units will reveal that apart from Light and Sound (these two studies are reserved for Grade X General Science), the student will have ample opportunity to work in the traditional areas listed above.

SPECIFIC OUTCOMES EXPECTED FROM THE UNIT STUDIES IN GRADES VII-VIII-IX

The teacher should refer to the three groups of specific aims or objectives of the Junior High School Science program, set forth on page 23. At the beginning of each series of units for grades VII, VIII, and IX the specific outcomes or objectives are summed up in brief form under the headings: "Understandings", "Skills, Abilities and Habits", and "Attitudes".

PATTERN OF UNITS

Every endeavor has been made to keep the pattern of the unit as simple as possible. A unit of study is a job to be done. It involves an area of science study (title), a purpose (goal), an arousal of interest (approach or motivation), starting the job, working at the job, getting the job done, and summing it up or appraising it. This is simple terminology that anyone can understand, but it really explains what the unit method is all about.

The general pattern of the unit studies is shown below.

PATTERN OF UNIT STUDIES

NUMBER OF THE UNIT and TITLE OF THE UNIT

SUGGESTED TIME ALLOTMENT FOR THE UNIT:

PURPOSE OF THE UNIT:

SPECIFIC OBJECTIVES OF THE UNIT:

SUGGESTED APPROACH TO THE UNIT:

SUGGESTED ACTIVITIES	UNDERSTANDINGS
(Content of the unit)	(Major ideas)
(There follows a list of suggestions, not prescriptions.)	(Here we find a small number of general ideas or concepts resulting from several particular studies and information.)

SUGGESTED ENRICHMENT ACTIVITIES

These additional activities are for those schools and students where a special interest or challenge is to be met. No new understanding, or understandings will be developed; rather, there will be an enrichment or expansion of previous understandings.)

CULMINATION, EVALUATION, AND AUDIO-VISUALS AIDS

In the detailed outlines of the units for grades VII, VIII, and IX, no specific reference has been made to the way to close off the unit study. The question of evaluation is treated in Chapter 8. The teacher should, from the time the unit begins, consider carefully the matter of testing, appraising, and evaluating student growth, as an integral part of the unit study. The use of films and film strips is advocated as a worth-while student experience in unit study. The teacher should refer to the film catalog prepared by the Department of Education in selecting appropriate films and film strips.

References: The reference materials which will be useful in working out the units have been consolidated in Chapter 9.

Comment on the Outlines of Unit studies in the Junior High School Science Program:

In order to assist teachers to organize the unit studies the eighteen units for the junior high school have been outlined for each of Grades VII, VIII, and IX in Chapters 5, 6 and 7. These expanded outlines may be used as ready reference material for the teacher. They follow exactly the scope and sequence found on the overall chart on page 38. The numbering of the units is a handy reference. For example Unit IX-6 represents a unit from the overall chart in Grade IX of the sequence, and deals with area number 6 of the scope.

CHAPTER IV

METHOD OF TEACHING THE JUNIOR HIGH SCHOOL SCIENCE PROGRAM

THE UNIT STUDY METHOD

The Scientific Method of Pursuing Unit Studies

For each of the three grades of the Junior High school, the six unit studies in science are to be explored by means of the scientific method. This is the method employed by the scientist in finding out about nature, about the life of plants and animals, and about our earth and the heavenly bodies. It is the method employed by man in dealng with the problems of his environment. The science program of the junior high school is built upon experience—learning situations in which research is used to solve problems.

The science course is centered around the scientific method of problem solving. This special skill is to be achieved under a democratic plan of group membership and group activity. The teacher should realize that the problem-solving method is the crux of the program. If teachers working with this new program realize that the scientific method, the problem-solving technique, the unit-study method, and the democratic classroom environment or atmosphere all have much in common, they will have caught the spirit of the science curriculum.

The Trend Toward Unified Learning or the Unit Study Method of Learning

In the simple social or group living of pioneer days, the adult citizen rarely moved far from the immediate vicinity of the small, local group. His mode of existence was generally peaceful, modifications in living were infrequent, and when they did occur, they were talked about for a long time.

In the schools of the pioneer settlement, the traditional learning consisted of facts to be memorized and monotonous drill under a stern taskmaster, with little or no attention to meanings and relationships to living. Children used up valuable hours in meaningless rote learning and in the mastery of many isolated details.

In today's complex society, the adult lives in a bustling and scientific world. It seems that we must accept the fact that change is continually taking place. In order to prepare youth for this swift-moving type of life, school learnings must become part of their own personal living directed toward solving problems in a complex society. Educators consider it important for children to learn the techniques of solving problems made meaningful by being related to the direct experiences of boys, girls, and of adult citizens. They consider that the ability to view the details of science content in relation to large wholes or units of subject matter is more advantageous than to require the mere memorization of answers

to questions. In fact, such memorization of science material without reference to the larger problem in hand, is falling into disrepute as a teaching method.

It is recognized today that curriculum content becomes meaningless if children are forced to learn, without understanding, such things as: the circumference of the earth, the chemical formulae for foods and complex vitamins, the formula for changing Centigrade to Fahrenheit temperatures.

This program proposes the more modern viewpoint of providing meaningful situations in which pupils must think through a series of problems. The teacher's function is to provide the meaningful situation, to set the stage, to arrange conditions so that children may learn with understanding.

This proposed viewpoint does not eliminate the need for planned lessons, drill, class discipline, and the need for rules to govern individual and group conduct. It does, however, center the educative process on the goals and purposes of the learner. Factual learning is not underestimated; it merely appears in a new light.

As schools experiment with the unit study method, the advantage of meaningful problem-solving in which pupils raise issues and discover answers for themselves, will be clearly demonstrated. This type of learning technique has been given various names in modern educational writings: project teaching, problem-centered teaching, unified learning, units of study, enterprises, core courses, general education courses.

The Steps to Follow in Pursuing a Unit

Viewed simply, the unit method may be looked at in terms of three major steps. These three steps are essentially equivalent to the seven steps of the scientific method shown on page 30. The tabulated arrangement below should make clear that the unit study method is the scientific method:

Major Steps In a Unit Study	Seven Steps of the Scientific Method
A. THE STARTING STAGE	Step 1—Sensing or recognizing the problem. Step 2—Defining or limiting the problem.
B. THE WORKING OR UNFOLDING STAGE	Step 3—Gathering data pertinent to the problem. Step 4—Proposing hypotheses to solve the problem. Step 5—Finding best hypotheses to solve the problem.
C. THE FINISHING OR ROUNDING OFF STAGE	Step 6—Reaching conclusions to the problem. Step 7—Applying the conclusions to new problems.

Let us now examine carefully each of the three stages in a unit study.

A. The Starting Stage

1. *The Purpose of the Unit*: The aim of the unit must first be clear in the teacher's mind and then, under careful direction by the teacher, become evident to all the pupils in the class. This is sensing or recognizing the problem. The teacher's role is to steer the unit study in line with the general and specific objectives of science teaching. He should review the four general objectives in Chapter 2 in order to satisfy himself that the unit is worth-while in terms of these objectives. He should also read carefully the specific objectives listed at the beginning of Chapter 5, 6, or 7 as well as the understandings listed opposite the suggested activities in the particular unit study. As the various studies proceed, the teacher will detect these objectives "in operation".

In the several outlines, a few understandings have been suggested as specific outcomes. The teacher and pupils may discover others. Understandings are to be sensed or expressed in words, and must not be assigned as something to be memorized. When a unit is finished, the teacher should try to train pupils to tell in their own words what understandings or general ideas they have obtained from the unit study. The suggested skills, abilities and habits are ways and means of arriving at understandings and establishing desirable attitudes.

2. *The Approach to the Unit*: This part of the starting stage includes the arousal of student interest and the setting of limits to the problem. After the students feel that a problem situation has arisen and that it bears some relationship to their immediate environment, the teacher should exercise his skill in devising ways and means of arousing intelligent curiosity, or interest, in the unit, so that the pupils will feel that the problem has become "their own". This is sometimes referred to as motivation.

The unit may be broken down into a few main sections in order to simplify the problem. Some teachers like to use the "overview" approach. This technique gives the students an overall picture of what the unit is about, enabling them to be on the lookout for suitable materials which will be helpful in carrying out the unit. (Pictures, articles, collections, specimens, etc.). In this way, students feel that they are actually taking part in the problem study. At this point the unit is now clearly defined as a special problem for the class.

B. The Working Stage

This stage corresponds to Steps 3, 4, and 5 in the chart on page 47. Students gather data, propose suggestions or hypotheses and find out the best ways to solve the problem. This is the stage of varied activity, of trial-and-error, of experiments. It is really the scientific method in operation with recognition of individual

capacities. Group and individual tasks get under way. Leaders and committees are working. Information is being gathered and sifted. Ideas pour forth from the minds of busy children. These ideas are evaluated; some are accepted, some rejected.

The teacher should draw from the suggestions in the unit study outlines but other activities may suggest themselves. As the work proceeds, pupils should display growth in skills, abilities, habits, and attitudes. The small number of understandings listed to the right of the proposed activities suggest general ideas that children should have after the unit is finished. Teachers might ask children to tell in their own words the main ideas they have learned. Some of these general ideas may be offered voluntarily or may be asked for by the teacher as the work stage develops. If, in a study of the Solar System, a child exclaims: "Gee! but the stars must be heavy."—this is an excellent spontaneous objective but requires polishing. The teacher's task is to "strike while the iron is hot" and have the child express himself in good scientific English. After suggestions and help from other class members the understanding might take the form: "Compared to our earth, stars are of tremendous size and weight."

The units reveal suggested activities. Teachers may accept, reject, or change any or all of the proposed activities in any unit. They must adapt the unit studies to their own class groups, in their own particular localities, remembering that all children are different, that socio-economic and geographic communities are different. They should be alert at all times to accept suggestions offered by pupils. If pupils are lacking in fertility of ideas, teachers must be prepared to supply this lack.

All through the working stage of the unit the teacher's role is to direct, help, teach, assign, listen, observe, sum up, and help with reports, discussions, and activities.

C. The Finishing or Rounding Off Stage

1. *Reaching Conclusions*: The finishing stage corresponds to Steps 6 and 7 in the chart on page 47. The problem or unit study should now reveal certain achievements in the form of information, principles, skills, abilities, habits, and attitudes. The solution to the problem study will be further expressed in terms of several general understandings. The unit may then be summed up by teacher and pupils to indicate what special knowledge has been gained.

The class will arrive at certain definite conclusions. Some conclusions will be final, others may be only tentatively established.

The class may wish to dispose of the work on a particular unit in a special way. If an interesting and varied accumulation of display materials, written essays, and such-like have been gathered, these might be shown to parents, to another class or

school, or to a Home and School Association Meeting. A special diary, scrap-book, or mural might be planned to show the sequence of development of the study. A class might plan a well-made scrap-book for each unit studied in the year, these to be placed in the school library at the end of the year, or exchanged for those prepared in schools in other provinces or countries.

2. *Application of the Unit*: Teacher and students might consider the following applications:

(a) Applying the conclusions to life situations in Alberta, Canada, and the world. This will serve to clarify and extend the understandings and principles learned.

(b) Applying the understandings, skills, abilities, habits, and attitudes to other units, to other subjects, or to their own behavior.

Evaluating the Unit Study

It should be made clear that evaluation is not a special or final stage of the unit study. Evaluation of student growth goes on continuously in the mind of the teacher from the very initiation of the unit study. For a detailed treatment of evaluation, see Chapter 8.

Special Suggestions for Handling the Unit Method

Special suggestions for handling the unit method will be treated under the following headings: Student Reports, Experimental Work, and Home Assignments.

Student Reports

There has been much criticism of student report work, both in enterprise and unit study teaching. Pupils need careful direction and help in preparing, presenting, and summing up reports. The ability to give a good report is not inborn in the student. Since reporting constitutes a learning situation, the teacher must assume the responsibility for developing this skill.

Many teachers have not yet made the most of this very worthwhile pupil experience. It should be recognized that the unit study technique demands more teacher responsibility and effort than traditional methods. Class discipline, where students work in groups in an atmosphere of busy endeavor, is more difficult to control than is a teacher-lecture situation with students seated at individual desks.

1. *Assigning the Report and Helping With Its Planning*:
   a. The students with the help of the teacher, choose suitable report topics.
   b. The report topic should be suited to the interest and ability level of the individual student.
   c. The individual assignment or report topic should be clear and limited in scope.

d. The students should be directed to specific and available references. The teacher should endeavor to provide a variety of references.

e. In the early stages of unit study learning, class time will be used in order to indicate to the students what a good report should include. (See criteria in ¶3 (e) below.)

2. *Presenting the Report*:

a. The teacher should help the student make the report "his own". If the student cannot give a report in his own words, the report is of questionable value.

b. Mass copying of material from books, or memorizing text material for reports is to be avoided. If a student makes brief quotations he should indicate this fact.

c. Students should not be expected to copy great masses of teacher-written or student-written notes from the blackboard.

d. Students may use brief notes or a summary outline to guide their talk.

e. The student may write on the blackboard five or six questions which he proposes to answer in the body of his report.

f. The length of a report depends on the student's ability, the topic in hand, material available, and general interest.

g. Reports should be varied and informal. The formal type of introduction may be used occasionally to acquaint the students with this method. If used to excess, however, it becomes monotonous.

Note: The teacher should enrich the report by contributing interesting new material, stressing important points, and directing a summary.

3. *Appraising the Report*:

a. The teacher should evaluate personal qualities of the reporter (See Chapter 8).

b. The report should be carefully evaluated for good oral expression. This should include an interesting introduction, good sentence structure, stress on main facts or points, and a fitting conclusion.

c. The teacher should observe carefully the class reaction to the report.

d. Class understandings may be tested by means of oral questioning, paragraph writing, or objective tests.

e. The students should be encouraged to evaluate their own reports by answering the following questions:

Was the topic or assignment clearly defined?
What were your sources of information?
Did you make use of the blackboard, pictures, samples, or diagrams to make the report more vivid?

Did you organize the topic or assignment around four or five main ideas or facts?
Did you use correct English?
Did you use scientific terms with understanding?
Did the class find the report interesting throughout?

This list of questions might be posted on the bulletin board or in conspicuous chart form for constant reference by teacher, report leaders, chairman, and reporters.

Experimental Work

Because of its objective and practical nature, experimental work is a valuable skill for children to acquire. In all experimental work the teacher guides, and the students participate where they can. As much individual and small-group experimental work is to be carried out as time and facilities will allow. Experiments with strong acids or other dangerous materials, however, should be performed by the teacher. In developing a topic or in carrying out an experiment the teacher should encourage active discussion. In dealing with experiments pupils should get the "feel" for the scientific method. For example:

1. An issue is raised (usually in question form).
2. The teacher or group chairman asks for opinions or guesses (hypotheses).
3. These suggestions are written on the board and evaluated in terms of evidence available.
4. The group proposes suggestions to solve the problem: (Readings, personal authority, writing for information, experimentation).
5. Individuals or groups (not the teacher) tell what information the experiment reveals, and how it answers the original question.
6. Other evidence is brought to light such as other experiments, other experiences, other book references.

Teacher and students sum up their experimental findings and record them briefly in their notebooks. Suggested headings for experiment reporting are: (1) The problem as defined, (2) The problem investigation, (3) The problem answered.

Home Assignments

Home study and research (the term "homework" suggest drudgery) should be the direct outcome of class work and class activity which goes on in the working stage of the unit. The best type of home assignment is not the note-copying or note-making-from-book variety, but rather the kind that is searching, challenging, creative, and that develops the child's thinking powers. In order to give it purpose the assignment should be a vital part of the unit.

An assignment requiring reading for report work and involving home preparation is definitely worthwhile. Children may even be asked to plan the set-up for an experiment or to make a

simple model, providing, of course, that instructions are definite, not too time-consuming, and within the child's level of maturity.

Summary of Ideas Regarding the Unit Study Method

1. The Unit Study Plan is recognized as admirably suited to achieve the general and specific objectives listed in this program.
2. The Unit Study Plan is a unit of experience consisting of closely related activities selected to solve the problem situation faced by the learner.
3. The Unit Study Plan suggests a quality of unity. This unity is really the pattern which characterizes the scientific method, viz., defining a problem, planning a solution, and carrying out the plans successfully.
4. The Unit Study Plan requires the continuous teacher-pupil planning of activities. Teacher guidance is very important because the teacher is the one person who best understands the maturity level, background, and personality of the students in his particular group.
5. The Unit Study Plan requires on-going revision or change in original plans because new needs arise and pupils bring in new suggestions.
6. The Unit Study Plan requires a variety of instructional materials: books, audio and visual aids, community resource materials, equipment for experiments, and materials for construction work.
7. The Unit Study Plan must be viewed in terms of purpose and interest. The preliminary overview affords an opportunity for the teacher to assess pupil ideas and suggestions relative to launching the unit study.
8. The Unit Study Plan cannot be carried out without adequate source materials and references.

OTHER CLASSROOM PROCEDURES AND MATERIALS

1. General Science Equipment and the Science Classroom

Special equipment for the teaching of general science is as essential as for the teaching of art and dramatics. The following factors should receive consideration for the adequate handling of general science at the junior high school level:

1. A science demonstration and experiment table.
2. Adequate cupboard and storage space.
3. Sufficient work space.
4. A water supply, and, if possible, gas and electricity.
5. Equipment for handling a wide range of activities (see list of recommended materials and equipment, in Appendix B).

2. A Science Corner for Experimentation

This is a worth-while project especially in rural schools, and in those town schools lacking a special science laboratory. A picture of a science corner is shown below.

3. Setting Up a School Museum

A well-arranged museum, containing materials made by students and brought from home, will motivate the learner in many of the unit studies. The museum should be checked over periodically to eliminate useless and out-dated or worn-out material.

A SCHOOL SCIENCE CORNER

4. Experiments and Demonstrations

Demonstrations by both the pupil and the teacher are an essential part of a good science program. In order to save time and money, teacher demonstration, rather than individual performance of experiments may be resorted to on occasion. Teachers should be conscious of "dangerous" types of experiment. If performed, they should be conducted by the teacher.

5. Home-made Equipment

There is a considerable amount of learning and understanding which results from the manufacture and improvising of home-made equipment. Such items as: a pneumatic trough, retort stands, wire mesh, alcohol lamps, water pressure system for the

science corner, graduates, balance, test-tube stands, test-tube holders, test-tube racks, expansion apparatus, may all be improvised by the student under the direction of an imaginative teacher.

6. Current Events in Science

Since students show a great deal of interest in modern invention and discovery, periodic discussion of current events in science should form a part of classroom activities.

7. A Student Notebook

The student's notebook should reflect his own interest and effort. The notebook, preferably loose leaf, should contain important summaries of student reports, teacher's summaries of significant information, clippings from periodicals and newspapers, records of experiments, vocabularly list of new science terms, answers to thought questions, simple labelled diagrams, short-answer test items. Long, involved science "stories" of performed experiments are too time-consuming and are not justified from the standpoint of writing by the student or correction by the teacher. Elaborate, exact, and artistic drawing of apparatus set-ups and biological specimens is not justified in terms of resultant values to the student. Inking or coloring of "lab" drawings is not considered pyschologically sound practice. Having students copy elaborate and detailed drawings from textbooks is a questionable procedure.

8. Scrapbooks

This is the type of activity that appeals to certain students, but not to all. The scrapbook should not become a book of scraps. There is an excellent opportunity for the transfer of habits learned in the art class to carry over into the student's science notebook and the class scrapbook.

9. Specially Prepared Science Workbooks or Manuals are not Recommended in This Course

This program emphasizes the importance of fitting the course to the local situation. For this reason, a science workbook or manual designed for use in all the schools of the province would defeat the objectives planned for varying classrooms and for different communities. The rigidity resulting from the use of a specific workbook or manual is diametrically opposed to the spirit of the course.

10. The Science Club

Such an organization may well take over the arrangements and planning for visits to field and factory, communications with provincial authorities on the formation of calf and swine clubs.

11. Bulletin Board

The school or classroom bulletin board should contain a section

for current clippings from newspapers and periodicals under the heading of SCIENCE.

12. Field Trips or Excursions

In planning an excursion or field trip, three parts are essential: (a) the preplanning or purpose of the trip, (b) the trip itself, (c) the follow-up discussion to sum up what information was gained. Appropriate understandings from excursions to nature's laboratories and to industrial plants will be guaranteed if observation is carefully directed, and is followed by post-trip reports.

13. Collections

Many students show a marked aptitude for collections, and such an activity often leads to life hobbies. Much satisfaction is gained from gathering, planning, arranging, labelling, and titling. Pupils may collect samples of soil, leaves, seeds, rocks, plants, minerals, cloth, wood, fur, etc.

14. Requesting Free Materials

Writing letters to companies, government departments, or other organizations, requesting free material can be an educative experience for the students. All such letters, however, should be approved by the teacher. Needless to say they should be correct in form and English, clearly and neatly written and reflect courtesy and thoughtfulness. It is important that each letter state clearly why the material is needed, and in what grade it will be used. Only one request should be made for each classroom. The letter may be written as a group undertaking, or the best letter selected and forwarded. It should be pointed out that several commercial concerns have stopped sending free materials because of indiscriminate ordering by school children.

15. Audio-Visual Aids

In the Working Stage of the unit study, visual aids of all types will add to the success of the study. Pupils make charts, diagrams, mount pictures, watch films and slides. Graphic representation of factual knowledge may strengthen understandings. Films, filmstrips and slides must not develop into a "picture-show". All visual aids should be talked about and discussed fully. Films should be shown with a definite purpose in mind. After the showing, the pupils should decide whether or not the film has served its purpose. This is an excellent opportunity to correlate science and language by means of oral discussion. In order to gain the greatest benefit from the use of films as an aid to teaching, it is hoped that in time divisional libraries will contain a film bureau.

Films and Filmstrips from the Department of Education

Teachers should order from the Provincial Department of

Education suitable films and filmstrips listed in their film catalog. Such films may be used in the unit study to orient, to clarify, and to supplement, and must be selected according to the maturity of the children.

A Final Point of View Regarding Teaching Methods

It should be borne in mind at all times that the ideal organization of a science program, as presented in print, or the most thorough outline of a teaching method, can in no wise take the place of the efforts of an intelligent, imaginative teacher with an inspiring personality. So too, the forward-looking attitude of a school superintendent and his appreciation for the broad outcomes of a science program far outweigh all that can be written in a program of study.

The program of study can merely give guidance, and reveal a point of view. This guidance, coupled with various suggestions regarding content and method, is as much as can be expected from this curriculum guide.

CHAPTER V

UNIT STUDIES FOR GRADE VII

SPECIFIC OBJECTIVES FOR GRADE VII UNIT STUDIES

A specific objective is a single aim or goal which gives direction to some phase of learning in a particular unit study. As the teacher plans and works out the unit studies with the students, he should consider how the general objectives (discussed in Chapter 2) are translated into action by means of specific objectives. Specific objectives state in more or less exact terms the results that may be expected from the particular unit of work. Since they are stated in terms of pupil behavior or pupil experience, the evaluation of student effort and performance should be made in terms of these specific objectives.

The specific objectives for this course of study are divided into three main groups: (1) Understandings, (2) Skills, abilities and habits, and, (3) Attitudes.

(1) *Understandings*: These will be found in the right-hand column of the unit study outlines. Each understanding appears opposite the suggested activities which are considered best suited to develop that particular understanding.

(2) *Skills, abilities and habits,* and (3) *Attitudes*: Examples of these two are listed below. Since these examples apply to all the units of the Grade VII course it was thought best to place them all together, previous to the study outlines, rather than to give a complete list of specific objectives for each unit. For each specific objective listed below, illustrations of activities, taken from one or more of the Grade VII units, are given to show how these activities contribute toward the attainment of the specific objectives. It should be noted, however, that these are merely illustrations, and that each specific objective will apply to activities in units other than those indicated or to other activities within the same unit.

SKILLS, ABILITIES, AND HABITS

Students are expected to develop appropriate skills, abilities and habits in the following areas:

A. Graphic Arts (Making and interpreting charts, maps, diagrams and simple illustrations)

Examples: Unit VII-1: drawing animal structures to show basis for classification.

Unit VII-1: making a chart which illustrates the distribution of animals in a given locality.

Unit VII-3: making star diagrams.

Unit VII-1: making and interpreting a map showing the migratory travel of American birds.

Unit VII-5: making and interpreting carefully labelled diagrams of machines.

B. Communication (Oral and written expression)

1. Summarizing a discussion for permanent record purposes: e.g. Unit VII-1: classification of animal types.
2. Organizing and presenting oral reports: e.g. Unit VII-1: how animals adjust to their particular habitat.
3. Understanding clearly and spelling correctly words used in science: e.g. Unit VII-1: "mammal", "vertebrate", "habitat".
4. Expresing ideas in a simple paragraph: e.g. Unit VII-2: The Rat Menace.
5. Organizing ideas for an essay: e.g. Unit VII-2: Animal Structure and Adaptation.
6. Listening attentively to oral reports by pupils or to a teacher-presented lesson: e.g. Unit VII-2: A Study of Mimicry.

C. Reading

1. Reading and re-reading for understanding
2. Skimming for information
3. Using the index and table of contents in searching for information.

   Example: Unit VII-1: Characteristics of Mammals.

D. Organizing Materials (Collecting, selecting and arranging)

Examples: Unit VII-1: making a suitable science scrap-book of zoo animals.

Unit VII-4: displaying carefully selected specimens of rock in a meaningful and vivid arrangement.

E. Use of the Scientific Method

1. Arriving at general conclusions from many specific examples: e.g. Unit VII-5: experiments with levers.
2. Using the scientific method: e.g. Unit VII-6: Properties of Magnets.

F. Experimental Work

1. Manipulating laboratory equipment
2. Interpreting experimental phenomena
3. Writing reports on experiments

   Example: Unit VII-4: Water Seeks Its Own Level.

G. Social Relationships

Leading and following in committee work: e.g. Unit VII-2: Animal protection studies.

H. Mechanics

e.g. Unit VII-6: Making a telegraph set; taking an electric bell apart.

ATTITUDES

Students may be expected to show improvement in the following behavior traits:

1. Self Respect (including initiative, resourcefulness, and self reliance)

Examples: Unit VII-3: locating constellations

Unit VII-6: making a home model telegraph set; learning the Morse Code.

2. Creativeness

(a) In communication skills: e.g. Unit VII-1: writing paragraphs in connection with "Reptiles Then and Now".

(b) In drawing: e.g. Unit VII-1: diagram work in connection with a report on insects.

3. Scientific Attitude

(a) Open-mindedness

Example: Unit VII-3: suspending judgment when proof is wanting (Theories about the heavens.)

b) Curiosity and inquiry

Example: Unit VII-1: reading to learn about the characteristics of mammals.

4. Cooperation

Example: Trying to enjoy teamwork in solving a unit study problem.

5. Responsibility

This includes being responsible for completing assigned or voluntary tasks in connection with a unit.

Example: Unit VII-2: preparing individual essays on "Modifications of Animal Structure".

6. Social Concern

Example: Displaying courtesy toward others when working in a science committee.

7. Reverence

(a) For the work of the scientist; e.g. Unit VII-5: A study of inventions.

(b) For the order and immensity of the universe; e.g. Unit VII-3; A study of light years.

UNIT VII-1:

ANIMALS—A BRIEF STUDY AND SIMPLE CLASSIFICATION

Suggested Time Allotment: 6-8 weeks

Purpose:

To assist pupils to learn the scientific way of naming and classifying animals. To have students realize the past and present improvement in specialization of animals as they have adjusted and continue to adjust to their environment.

Specific Objectives:

See understandings listed to the right of the suggested activities. Refer to pages 58 to 60 for skills, abilities, habits and attitudes.

Suggested Approach

A class discussion on the wild duck (or any other suitable animal) according to the following pattern:

A. Habitat

B. Special body structure in relation to
   1. Breathing
   2. Feeding and Growth
   3. Reproduction

C. Summary of general adjustment to environment.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major ideas)
Part I—Introduction and General Classification	Animals differ from plants.
The teacher leads a discussion to show that animals differ from plants mainly in method of locomotion, methods of feeding, absorption rather than making of food, quickness of reaction in defense.	
The teacher might discuss some of the following body functions in order to show increasing specialization; circulation, breathing, central nervous system. These examples should be treated very simply.	There is a gradual scale of improved specialization of body structure among animals.
The class is divided into groups for a contest, the object of which is to discover who can come nearest to naming an animal, the name of which starts with a certain letter of the alphabet. In this way a list of animals is built up. The teacher, supplementing the alphabetical list of animals where necessary,	Animal groups possess definite characteristics which form the basis for a system of classification of all animals.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
leads a discussion on different types of animal. A simple group classification is developed and placed on the blackboard. The following is an example: Non-backboners (Invertebrates): worms, shelled animals, spiders, insects Backboners (Vertebrates): fish, double-life animals, reptiles, birds, mammals If other types are suggested they may be included. The class is then divided into groups (if class is small, organization is adapted) and topics assigned for study and report. In each report, features are considered such as habitat, structure, life-cycle, defenses, feeding, and specialization which helps adjustment to habitat.	Animals may be divided into a number of convenient broad divisions based upon framework or structure.
Part II—Invertebrate (Non-backboners) The following classification of invertebrates will prove valuable as a guide to assignments for study and report. 1. Worms (segmented): study of the common earthworm and, if desired, the tapeworm. 2. Soft-bodied animals in shells Class-study of snails *Assigned reading*: clams and oysters (Molluscs and crustaceans); limestone and chalk formations (e.g. Exshaw) in relationship to animal shells. 3. Hard-bodied animals in shells *Diagrams and sketches* (or actual studies) of the lobster and the crab. *Reports*: anatomy, and methods of fishing of the lobster and the crab. 4. Spiders and insects *Assigned group reading, diagram studies, and student reports* on the structure and nervous system of in-	

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
sects with special emphasis upon blood color and temperature. *List* of differences between spider and insect. *Assigned written work*: two short paragraphs on the life-history and control of the following insects; grasshopper, wheat-stem saw-fly, aphid, cutworm, clothes moth. (planning resumé material for the scrapbook under the heading "Invertebrate Animals" may commence at this time. Include clearly labelled pictures, diagrams, or sketches.)	
Part III—Vertebrates (Backboners) (At this point the class committees are reorganized and the new commitees proceed with a study of vertebrates. In this part a certain amount of reasonable dissection of animals may be permitted. The class might even like to visit a packing plant). The following classification will prove valuable as a basis for study and report. **COLD-BLOODED** 1. Fishes Continued reading, reporting and scrapbook work on the fish (anatomy, habits, etc.) 2. Double-life animals (amphibians) *Observation*: Students bring spawn or tadpoles to class and observe and record developments. *Research*: One student finds out differences between toads and frogs. 3. Reptiles *Assignment*: Written paragraph on "Reptiles Now and Then". *Collections*: Students collect, for inclusion in the scrapbook, pictures of reptiles of long ago, local reptiles, reptiles of other lands. *Reports*: Report on kinds of snakes	

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
in Alberta, their method of locomotion and of shedding skin, and their life habits.	
WARM-BLOODED	
1. Birds	
Report: Special committee report on birds.	
Diagram: Preparation by student of carefully labelled general diagram (forefeet replaced by wings, hollow bones, etc.)	
Chart: Drawing by student of a chart to show how different birds have different feet and bills to suit their habitat (swimmers, divers, waders, scratchers, snatchers, perchers)	
Map Work: Drawing of map, by students, showing migratory routes of birds which pass through Alberta. Teacher makes reference to the "mystery" of migration.	
Student-prepared list of birds common to Alberta.	
2. Mammals	
Reading: Students read to discover the characteristics of all mammals. Students make a list or gather scrapbook pictures of mammals of the world.	
Map work: Map of Canada showing the location of mammals in relation to tundra-land, coniferland, prairie land, mountain land.	
Spelling match using names of world mammals.	
Class discussion: Teacher selects a few mammals and leads discussion on their special adaptations, e.g. kangaroo, elephant, giraffe, cat, beaver.	
Scrapbook work: A student arranges a section of the scrapbook in three divisions: water - mammals, land mammals, air-mammals.	

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
Assignment: Written paragraph on Alberta rodents. (A special paragraph could be entitled "KROOA; Keep Rats Out Of Alberta"). (At this point plans are completed for a resumé section of the scrapbook, under the heading of vertebrates).	
Part IV—Value of Animals to Man Student-prepared list of harmful and beneficial birds and insects. *Class discussion*: The value of all mammals to man (clothing, work, food), with emphasis on the fur-bearing animals of Canada.	All animals are important to man.

SUGGESTED ENRICHMENT ACTIVITIES

Sketch comparisons to show how man has used the "design" structure of insects, fish and birds in planning modern transportation machines on land and sea, and in the air. (e.g. jet propulsion from the squid; streamlining from the fish; wing structure from birds and insects).

Insect collections (one good collection from the class)

Complete classification of animals by including:

(1) One-celled animals; try to find a paramecium in pond scum, in an aquarium, in sludge, or in water, using a microscope or magnifying glass.

(2) Pore-structured animals; read to find out all about the sponge.

(3) Hollow-gut animals; committee formed to read and report on corals and jelly fish.

UNIT VII-2:

LIVING THINGS ARE ADAPTED TO THEIR ENVIRONMENT FOR PROTECTION AND FOOD-SEEKING

Suggested Time Allotment: 4-5 weeks.

Purpose:

To have the student learn that adjustments are made by all living things to help them obtain food and to protect themselves in one way or another.

Specific Objectives:

See understandings listed to the right of the suggested activities. Refer to pages 58 to 60 for skills, abilities, habits, attitudes.

Suggested Approach:

Using a rabbit and a well-known plant show how both are well adapted to obtain food and to protect themselves in various ways.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major ideas)
Class discussion: In the course of the discussion the teacher makes a blackboard outline of examples of plants and animals that use color as a protective device. The trick of "freezing" by animals should be noted. *Class activities*: Listing ten examples of animals and ten of birds which escape capture by speed. Listing, within a given time limit, as many animals as possible which protect themselves by teeth and claws. *Committee work*: Committee report on other distinctive forms of protection; e.g. skunk (odor), porcupine (quills), gopher (burrows), grebe (diving), bee (sting). Committee to gather information on how plants protect themselves from animals. *Writing assignment*: Paragraph on how a certain animal misleads its enemies; e.g. duck using broken wing technique. *Teacher*: Explanation of mimicry in nature.	Living things adapt themselves for protection against other living things.
Group work: (class divided into 3 groups) Each group prepares a chart showing how the teeth, lips or bill, tongue, etc. of animals have been modified to obtain the food they require. (Mammals, birds, insects). *Individual assignment*: Each student writes an essay on special modifications of the feet of mammals, birds, or insects, which aid them in obtaining their food. *Class discussion*: With the help of the class, the teacher outlines various other body modifications which aid animals in the securing of food. (torpedo shape of fish, slender body of weasel to enter burrows). EXPERIMENT to show that plants give off moisture (transpiration).	Plants and animals are specially adapted to obtain the food they require.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
EXPERIMENT to show osmosis as part of the process of food-getting from the soil by plants. The teacher should explain how a plant leaf manufactures food (photosynthesis). EXPERIMENT to show how plant leaves always turn to face the light (tropism). *Investigation*: Examination of spider webs to find out how they are constructed to trap insects for food. *Reading assignment*: Obtain information on: how animals protect themselves against cold; the life-cycle of insects; how plants adapt themselves for survival against (1) seasonal changes, (2) changing moisture conditions, (3) difficulties in obtaining food. *Summary activities*: Scrapboard display. *Testing*: An extensive test on the three parts of this unit prepared by the teacher to evaluate understandings and knowledge gained. Diagram might be required to test certain parts of the unit study.	All living things adapt themselves to adverse physical conditions.

SUGGESTED ENRICHMENT ACTIVITIES

An individual or class zoo-booklet to show how living things protect themselves. The booklet should be carefully planned, organized and illustrated.
Starting an aquarium
Report on "Insect-eating plants"

UNIT VII-3:
BEYOND OUR SOLAR SYSTEM

Note: Units VII-3, VIII-3, and IX-3 are organized so that the students proceed from the "remote" to the "near-at-hand". This may appear to be contrary to a well-known learning principle, but the sequence is justified on the basis of proceeding from the "simple" to the "more difficult". The content and understandings have therefore been planned in a sequence of increasing complexity for different levels of maturation and ability. The story material connected with constellations can be readily adapted to a Grade VII class. On the other hand, time-telling and related computations, causes of the seasons, eclipses, etc., are better suited to the level of Grade IX students.

Suggested Time Allotment: 6-8 weeks.

Purpose:

To develop an interest in and an appreciation of the "vastness" of the universe.

Specific Objectives:

See understandings listed to the right of the suggested activities. Refer to pages 58 to 60 for skills, abilities, habits, attitudes.

Suggested Approach:

The students read to find out what early people thought of the stars and the heavens and how they made use of stars to find their way.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major ideas)
Class discussion: Early strange theories about the heavens; modern theories (Ptolemaic, Copernican).	Man's ideas of truth about the universe change.
Contrast between modern and early ideas about the stars.	Stars are suns and suns are stars
Observation: Students observe the sky to see how many different colored stars they can find.	The universe is made up of many thousands of different kinds of heavenly bodies.
Reading: Reading to find out about: the different sizes of stars in space, the names of the largest and brightest stars we can see.	
Observation: Students observe stars to see how many familiar "objects" they can recognize in bright stars which are grouped close together. Students should be encouraged to use their own imagination.	Some stars are grouped in constellations.
Reports: Students report on the legends connected with several selected star groups. (This is a good opportunity for committee work.)	
Charts: Using a sky chart the students actually locate four or five main constellations in the sky; they then make a sky map showing only these constellations.	
Discussion: Reason why all groups of stars cannot be seen at the same time (seasonal constellations, southern stars).	

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
Assigned writing: Paragraph on the importance of the North Star in finding direction and as a pivot point of the earth's rotation.	
Research: Learning how to locate Polaris by using the constellation of the Big Bear.	
EXPERIMENTS: Finding "south" by means of the sun and a pocket (or wrist) watch. (This is a Boy Scout or Girl Guide test).	
Observation: The students try to estimate the number of stars they can see at night with the unaided eye.	No one knows how many stars there are, so man constantly seeks for more and new information about the universe.
Reading: People who first invented and used telescopes (Galileo, Newton); discover where some of the large telescopes are located. (Canada, United States, elsewhere).	
Research and report: Reading of articles in magazines, newspapers, or reference books on large telescopes, for purpose of giving a report.	
Teacher: Explanation of the speed at which light travels.	Star distances are examples of the vastness of space.
Calculation of the distance (in miles) in which light travels in a year (light year).	
Research: The students find, in light years, the distances from the earth of some well known stars. They then make some intelligent comparisons of their distances using a "time and distance scale" marked in units which they can understand.	

SUGGESTED ENRICHMENT ACTIVITIES

EXPERIMENT: Heat soft iron to white heat using a bunsen burner. Remove wire and observe color changes. Relate these observations to the colors of the stars.

Reading: How telescopes are made (Two kinds).

EXPERIMENT: Construction of a simple telescope.

Research: How can the correct time be read from the stars? (Big Dipper rotating around the North Star).

UNIT VII-4:

STORY OF THE EARTH'S FORMATION

Suggested Time Allotment: 6-8 weeks.

Purpose:

To acquaint the student with suggested theories which attempt to explain the earth's beginning, and to allow students to come to their own conclusions in the light of the facts as they are now known.

Specific Objectives:

See understandings listed to the right of the suggested activities. Refer to pages 58 to 60 for skills, abilities, habits and attitudes.

Suggested Approach:

The teacher should explain that the "Theory of the Earth's Beginning" is an excellent example of the scientific method in action. It involves a definition of a problem, gathering facts, making suggestions (hypotheses), testing data, making observations and inferences, arriving at tentative conclusions, reserving final judgment until more facts are obtained.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major ideas)
Assigned group reading: Our evaluation of various theories proposed over the years, which have attempted to explain the earth's origin and development.	Man's proposed theories change in the light of newly discovered facts.
Study: The composition of our "air blanket".	An air blanket surrounds the earth.
EXPERIMENT: Proof that the earth's air blanket has weight.	
EXPERIMENT: Making oxygen and testing its properties.	
Research: Examination of the globe to estimate the proportion of land and water on the earth's surface. (Particular attention should be paid to the polar areas).	The earth's surface is mostly water.
EXPERIMENT: Demonstration of the fact that water seeks its own level.	
Reading: Determine the differences in water levels at opposite ends of: the Panama Canal; the Suez Canal.	
Reports: Explanation of the following terms: sea level, continental divide, isthmus, estuary, strait.	

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
Research: Location on a world map of important examples of each of the above features. *Reading and research*: How man has attempted to divide the earth's history into long periods of time. (Avoid difficult geological terms); relation of the story of forms of life to the story of these time eras. *Report*: The story of the Grand Canyon. *Special committee report*: Dinosaur Days in the Red River Valley. *Assigned Reading*: The three types of rock in the earth. *Discussion*: Class discussion on how the three types of rock were formed. *Collections*: Museum collections of local rocks (Add rocks from other vicinities if possible). *Committees*: Diagram reports on the following: volcanoes, geysers, hot springs. *Essay assignment*: The Great Glacial Age in North America and its Relation to Present Day Glaciers. EXPERIMENT: A "settling" using silt, sand, clay, gravel, shells; relate obtained effect to layer formations in the earth's crust. *Teacher*: A review of the way in which limestone was formed. EXPERIMENT: Production of CO_2 (test with limewater). *Research*: Trace the limestone in a teakettle back to its first source.	The earth is very old in terms of our units of time. The solid part of the earth is made up of different kinds of rock.

SUGGESTED ENRICHMENT ACTIVITIES

Frieze work: Illustration of the various theories of the earth's origin.

Research: Investigation to reveal the theories which explain the formation of the earth's atmosphere.

Research: Securing of information on the extent and properties of the earth's atmosphere and the stratosphere, and man's attempts to penetrate the stratosphere.

Reports: The oil, gas, salt, and coal formations of Alberta and their relation to the story of the earth's past.

UNIT VII-5:

IDENTIFYING SIMPLE MACHINES

Suggested Time Allotment: 5-6 weeks.

Purpose:

To have students develop an appreciation of man's inventive genius in the past, and to have students recognize uses of simple machines in the immediate environment.

Specific Objectives:

See understandings listed to the right of the suggested activities. Refer to pages 58 to 60 for skills, abilities, habits and attitudes.

Suggested Approach:

A class discussion to show historically how man has ever tried to overcome the force of gravity. Refer to problems encountered in building the pyramids, or other large works of antiquity. Contrasts with modern weight-moving will no doubt arise.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major ideas)
Tecaher: Discussion of examples of work done by students during a normal day: introduce as many examples of simple machines as possible. Stress the idea of movement, and the fact that work is not necessarily useful. Stress also the idea that man has always tried to make his work easier. Have students hold books or other objects, then lift the books or objects a certain distance: from this develop the foot-pound as a unit of work. Estimate the work done by students in lifting themselves when climbing stairs.	Work must involve exerting a force over a distance.
Discussion of examples of each of the six types of machine, stressing the fact that a particularly useful type of work would be difficult or impossible without the aid of these simple machines. *Class*: Gathering scrapbook material to aid in the recognition of each type of machine; carefully labelling each part of the machine with a view to stressing the fact that machines have relatively few basic parts.	Simple machines are devices that make man's work easier.

Note: The activities and general learnings outlined below refer to the first class lever. A similar type of procedure should be followed for other types of machine. Models should be used to illustrate. Wherever possible, practical demonstrations should be introduced, showing these machines moving heavy weights; e.g., block and tackle lifting a weight of 300 to 500 pounds.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
EXPERIMENT: Working of a first class lever using a yardstick, selected weights and a spring balance.	Levers (and machines) require a "push", or force, to make them work.
Discussion: Examples of force being exerted by animals, power machinery, or by other sources. (e.g. lifting baled hay, tightening wire fences).	
Teacher: In dealing with the first class lever the lengths of force and weight arms should be varied to show that the force may be less than, equal to, or greater than the weight. In the first class lever experiment it should be demonstrated that, when the ratio of the weight to the force is 2 to 1, the distance the weight rises is half the distance the force moves.	A machine is used to gain some advantage.

Note: Teachers must be careful to go no further in mathematical calculation than the simple ratios of force and weight; e.g. 1:2, 1:1, 2:1, 4:1. Development of a specific mechanical advantage formula for each machine should be avoided.

Explanation of the terms friction, weight (gravity) and inertia, and illustrations of their presence in the experiments on machines.	Friction reduces the efficiency of machines.
Class research: Types of friction such as roller and sliding; the principle of the roller or ball bearing; the use of lubricants to overcome friction.	
Group project: Gathering scrapbook material to illustrate beneficial and harmful examples of the three types of friction.	

SUGGESTED ENRICHMENT ACTIVITIES

Reading: Finding out what happens to the energy "lost" because of friction.

Preparing lists: examples of useful friction.

Contest: listing the greatest number of examples (applications) of simple machines (egg-beater, plowshare, meat grinder, wire stretchers, etc.).

UNIT VII-6:

MAGNETISM AND SOME OF ITS USES

Suggested Time Allotment: 6-8 weeks.

Purpose:

To assist the student to develop general understandings about the way in which the discovery of magnetism led to a series of important inventions useful in our daily living. (All unit studies employ the scientific method and this unit lends itself well to experimenting, observing, trial and error, making guesses, drawing conclusions.).

Specific Objectives:

See understandings listed to the right of the suggested activities.

Refer to pages 58 to 60 for skills, abilities, habits and attitudes.

Suggested Approach:

Read the story of Michael Faraday's life and give an account of his famous discoveries on magnetism. The story should lead to the development of students' appreciation of the work of the scientist in contributing to our modern comfort.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major ideas)
Reading: Students read about the lodestone and other kinds of permanent magnet; read also to find the meaning of the word "lodestone."	Only certain materials can be magnetized or are affected by magnets.
EXPERIMENT: Determining whether or not magnetism "goes through" water, paper, wood, etc. Construction of a magnetic boat.	
EXPERIMENT: Discovery of the "strong spots" and the field of force around magnets by covering a magnet with paper or glass and using iron filings or a compass needle.	Like poles of magnets repel each other; unlike poles attract.
EXPERIMENT: Proof of the law of polarity of magnets, using a compass and a magnet. (The teacher should make clear the correctness of the term "north-seeking pole", rather than "north pole".)	

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
EXPERIMENT: Construction of a direction-seeking device, using a magnetized sewing needle and a flat piece of cork floating on water.	
Research: Through reading and by using the globe, locating the north and south magnetic poles and their relation to true north and south (magnetic declination).	
EXPERIMENT: Testing the broken parts of a magnetized needle for polarity. The student should be asked to try to imagine this process (breaking of magnets into smaller parts) carried on "ad infinitum".	Magnets are thought to be made up of small "molecular" magnets.
EXPERIMENT: Making magnets by stroking a permanent magnet with pieces of soft iron and steel; or, having students magnetize their jacknife blades.	
Research: Discovery of three ways in which magnetism may be destroyed.	
EXPERIMENT: A straight wire carrying an electric current is magnetic. (Use a compass or iron filings to test for magnetism).	Electricity and magnetism are closely related.
EXPERIMENT: The magnetic force of a wire is increased when coiled (a) around a pencil (b) around a soft iron core.	
EXPERIMENT: Construction of a model lifting crane using a simple "U" type electro-magnet.	
EXPERIMENT: Demonstration of the varying effects on a magnet of different strengths of current.	
EXPERIMENT: Test of the polarity of the simple electro-magnets the students have made. Test of the effect of changing the direction of the current.	
Assigned writing: A paragraph on "The Advantages of Electro-magnets Over Permanent Magnets". (Ease of controlling strength, of shutting off the magnetism instantaneously, etc.).	Because of his ability to control electro-magnets, man uses them for many of his conveniences.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
EXPERIMENT: Setting up an electric bell circuit to discover how and why a bells works. (Use cell, push button or switch, and bell.). *Diagrams*: Students draw carefully labelled diagrams of an electric bell, showing how it works. Red pencil used to trace the path of the current through the binding posts, magnet and armature. *Research*: Students examine a doorbell, motors in electric fans, washing machines, etc., to locate the electro-magnets. *Assigned writing*: Essay describing how the use of electro-magnets has changed our living. Less door-knocking, clock-winding, cutting hair with scissors, etc.).	

SUGGESTED ENRICHMENT ACTIVITIES

EXPERIMENT: Experiment with a dip needle, explanation of its use. (A dip needle is really a direction needle, or compass, turned sideways, or through ninety degrees).

EXPERIMENT: Using a simple home-made telegraph sounder and key, demonstration of how the armature works.
Learning to spell own name in Morse code.
Learning the whole Morse code.
Sending messages with a flash light.
Finding out about the work of Samuel Morse.

CHAPTER VI

UNIT STUDIES FOR GRADE VIII

SPECIFIC OBJECTIVES FOR GRADE VIII UNIT STUDIES

A specific objective is a single aim or goal which gives direction to some phase of learning in a particular unit study. As the teacher plans and works out the unit studies with the students, he should consider how the general objectives (discussed in Chapter 2) are translated into action by means of specific objectives. Specific objectives state in more or less exact terms the results that may be expected from the particular unit of work. Since they are stated in terms of pupil behavior or pupil experience, the evaluation of student effort and performance should be made in terms of these specific objectives.

The specific objectives for this course of study are divided into three main groups: (1) Understandings, (2) Skills, Abilities and Habits, and, (3) Attitudes.

(1) *Understandings*: These will be found in the right-hand column of the unit study outlines. Each understanding appears opposite the suggested activities which are considered best suited to develop that particular understanding.

(2) *Skills, Abilities and Habits*, and (3) *Attitudes*: Examples of these are listed below. Since these examples apply to all the units of the Grade VIII course it was thought best to place them all together, previous to the study outlines, rather than to give a complete list of specific objectives for each unit. For each specific objective listed below, illustrations of activities, taken from one or more of the Grade VIII units, are given to show how these activities contribute toward the attainment of the specific objectives. It should be noted, however, that these are merely illustrations and that each specific objective will apply to activities in units other than those indicated or to other activities within the same unit.

SKILLS, ABILITIES, AND HABITS

Students are expected to develop appropriate skills, abilities and habits in the following areas:

A. Graphic Arts (Making and interpreting charts, maps, diagrams, and simple illustrations)

Examples: Unit VIII-6: the story of lamps.
Unit VIII-1: classification of plants.
Unit VIII-4: the water cycle.
Unit VIII-4: world wind systems.
Unit VIII-5: Alberta's energy resources.
Unit VIII-5: atomic power.
Unit VIII-3: tides.
Unit VIII-5: heating systems.
Unit VIII-6: dry cells and light bulbs.

B. Communication (Oral and written expression)

1. Summarizing a discussion for permanent record purposes: e.g. Unit VIII-2: importance of micro-organisms.
2. Organizing and presenting oral reports; e.g. Unit VIII-2: plant and animal partnerships.
3. Understanding clearly and spelling correctly words used in science: e.g. Unit VIII-4: "convection" "capillarity".
4. Expressing ideas in a simple paragraph: e.g. Unit VIII-4: weather disturbances.
5. Organizing ideas for an essay: e.g. Unit VIII-5: energy study.
6. Listening attentively to oral reports by pupils or to a teacher-presented lesson: e.g. Unit VIII-5: structure of matter.

C. Reading

1. Reading and re-reading for understanding.
2. Skimming for information.
3. Using the index and table of contents in searching for information.
   Example: Unit VIII-1: kinds of mosses.

D. Organizing Materials (Collecting, selecting and arranging):

Examples: Unit VIII-4: a picture collection of types of erosion, suitably arranged on the bulletin board or in a scrapbook.
Unit VIII-1: building a collection of carefullly selected materials on cones and seeds.
Unit VIII-4: building a collection of types of soil.

E. Use of the Scientific Method

Examples: Unit VIII-3: the birth of the planets.

F. Experimental Work

1. Manipulating laboratory equipment.
2. Interpreting experimental phenomena.
3. Writing reports on experiments.
   Example: Unit VIII-4: expansion and contraction.
4. Using the magnifying glass and the microscope: e.g. Unit VIII-1: plant studies: Unit VIII-2: micro-organisms.

G. Social Relationships

Leading and following in committee work.
Examples: Unit VIII-1: leaf study.
Unit VIII-5: energy study.

H. Mechanics

Examples: Unit VIII-6: dismantling a car generator, or building an electric motor.
Unit VIII-6: learning to service and repair simple household appliances such as the fuse panel, electric iron, the electric wiring system.
Unit VIII-6: Using caution in handling mechanical and electrical devices.

I. Mathematics

Solving mathematical problems which arise in science.

Examples: Unit VIII-4: thermometers.
Unit VIII-4: the barometer and air pressure.

ATTITUDES

Students may be expected to show improvement in the following behavior traits.

1. **Self Respect: through submitting a good quality of work:**
   e.g. Unit VIII-5: diagram of a furnace system to illustrate energy changes.
2. **Creativeness: through a desire to do original work:**
   e.g. Unit VIII-6: making a mural of the history of lighting.
3. **Scientific Attitude:**
   (a) Open mindedness: e.g. Unit VIII-6: weather forecasting is not one-hundred per cent accurate.
   (b) Acceptance of cause and effect in the physical world, rather than belief in superstitions: e.g. Unit VIII-3: explaining the causes of the tides.
4. **Cooperation: through work in groups and committees:**
   e.g. Unit VIII-6; group examination of electrical fuses, light bulbs, etc.
5. **Responsibility: through learning to care for personal and public property:**
   e.g. Unit VIII-4: experimenting with a mercury barometer and with laboratory thermometers.
6. **Social Concern: through a willingness to secure materials for others to help them with their research and reports.**
7. **Reverence**
   (a) For the work of the scientist:
   Examples: Unit VIII-4: Torricelli's experiments.
   Unit VIII-5: Watt's work with steam.
   (b) For the tremendous amount of energy in the universe; e.g. Unit VIII-5.

UNIT VIII-1:

PLANTS—A BRIEF STUDY AND CLASSIFICATION

Suggested Time Allotment: 6-8 weeks.

Purpose:

To develop in students, (1) an awareness of their plant environment, (2) an appreciation of their dependence upon plants, and (3) the ability to recognize plant differences.

Specific Objectives:

See understandings listed to the right of the suggested activities. Refer to pages 77 to 79 for skills, abilities, habits, and attitudes.

Suggested Approach:

Discuss how prehistoric, ancient, and modern man has been

dependent upon plants for food, clothing, or shelter. Have students bring pictures of many different plants and let them try to name them and to describe their habitats.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major ideas)
Class discussion and reference to books: Discovery of the three main plant functions or processes; (a) photosynthesis or "light-building" for the purpose of making food (simple treatment), (b) reproduction by cell-division, and by the combining of two unlike cells, (c) respiration or breathing.	There are different processes going on within plants.
Listing: Students list familiar plants, parts of which are used for food by animals and people. *Charts*: The students use this list to make a chart, each section of which shows plant foods that come from one particular part of the plant; e.g. stems, leaves, roots, seeds, flower. *Discussion*: Students express their opinion on the above schemes of classification. (Question should be raised: "Is this classification sufficiently comprehensive?") *Assigned writing*: Article on "Plants, the Supporters of All Life". *Committees*: (1) classification of leaves according to shape (structure) (2) report on all seed plants that members know (reproduction) (3) list all plants found around and in a slough (habitat). *Charts*: Plants classified according to length of life (annuals, etc.). *Class discussion*: Teacher leads a discussion on the scientific classification of the world's plants.	The main difference between most plants and animals is that plants manufacture food from basic material.
Committees: A committee investigates each of the following broad divisions of plants: 1. Simple-bodied plants (Thallus—no true leaves, stems or roots). (a) Fungi—reading and discussion on bacteria, yeasts and molds (include wheat rust, smut, and mildew) with particular reference to habitat, means of reproduction, ideal condi-	Plants may be classified into a few broad divisions according to their similarities and differences.

(Content of the unit) SUGGESTED ACTIVITIES	UNDERSTANDINGS (Major Ideas)
tions for growth, food required, beneficial and harmful tpyes. (b) Algae—reading and discussion on pond scum and sea weed with reference to reproduction, habitat, and food. 2. Moss groups of plants: reading and study on mosses and liverworts, (live on land, no vascular system, reproduction, etc.). 3. Fern plants: Committee collects pictures or makes sketches of ferns, club mosses and horse tail. A separate committee describes their characteristics, i.e. habitat (mostly on land), means of reproduction, part in the formation of coal (first really big prehistoric plants), underground roots, stems, leaves, and appearance of a food-distribution system. 4. Seed plants: (a) plants with naked seeds (non flowering): committee gathers a museum collection of cones (pine, fir, spruce). A committee discusses the characteristics of evergreens and indicates their economic value. (b) plants with enclosed seeds (flowering). EXPERIMENT: Students dissect a flower; draw cross-sectional diagram with all parts properly labelled. *Committee*: Discussion of the various methods of seed dispersal. *Charts*: Students make charts showing methods of seed dispersal (hurlers, sailers, shakers, etc.). EXPERIMENT: Teacher conducts seed tests for starch and fat. *Excursion*: Class divided into five groups to collect and mount samples of each of the following five seed plant families: grass, rose, pea, mustard, thistle. *Assigned writing*: The value of the grass family to Albertans in village, town, and city.	

SUGGESTED ENRICHMENT ACTIVITIES

Collection: Making a collection of seeds or plants; mounting and labelling samples suitably.

Research: Testing various seeds for germination.

Scrapbook: Pictures or drawings, or both, of different Canadian plants.

UNIT VIII-2

LIVING THINGS MAKE USE OF OTHER LIVING THINGS (INTERDEPENDENCE)

Suggested Time Allotment: 4-5 weeks.

Purpose:

To make the student aware of the struggle to obtain a balance in nature and to clarify the idea of interdependence.

Specific Objectives:

See understandings listed to the right of the suggested activities. Refer to pages 77 to 79 for skills, abilities, habits, and attitudes.

Suggested Approach:

Trace out a food cycle from plant, through animal, back to soil and into plant again. Use suitable local example.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major ideas)
Reading assignment: Students read in following references for a preview understanding of the whole unit. SCIENCE PROBLEMS 1 (1951 edition) Unit 10, pp. 326-367. BASIC SCIENCE EDUCATION SERIES; "Balance in Nature". *Listing* by each student of a number of "food chains". *Discussion*: Discussion and criticism of the student-prepared lists. *Group research and report*: Class divided into three groups to report on: (1) plant and animal struggle, (animals eat plants, bacteria eat animals), (2) animal versus animal (use each other for food), (3) plant versus plant (Saprophytes). *Chart study*: Discovery of methods used by a large city or town community to control bacteria in their drinking water	A constant struggle exists to achieve a food balance in nature.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
and in their foods (e.g. water supply systems, chlorination, pasteurization of milk, inspection of meat, refrigeration, garbage disposal, provincial Department of Health regulations regarding sanitation in restaurants, hospitals, etc.).	
EXPERIMENT: Experiment on sedimentation using muddy water and alum (flocculation).	
EXPERIMENT: Construction of a filter for muddy water using either filter paper and a funnel or a lamp chimney filled with clean sand.	
Group reports: (1) Plant and animal partnerships (bees and flowers, etc.). (2) animal partnerships (ant and aphid, etc.), (3) plant partnerships (lichens as a green algae and fungus), (4) plant and non-life partnership (composition of air, the water cycle, the nitrogen cycle etc.), (5) animal and non-life partnerships (maintaining composition of air, the water cycle, nitrogenous foods).	Cooperation exists to achieve a balance in nature.
Class project: Building an aquarium and maintaining it in a healthy condition. (e.g. murky water is a sign of too many plants).	
Teacher: With help of class, teacher develops a blackboard outline of the many ways in which man upsets the balance of nature (breaking land, draining swamps, killing certain animals, introducing new types of plant and animal, DDT, 2, 4-D, etc.).	The balance of nature can be disturbed.
Individual reports: Problems created by congestion of human population, e.g. lice, mice, rats, cockroaches, bed-bugs, fleas on rats (bubonic plague), polluted water, etc.).	

Note: A very good summary of the unit could be made by building up and discussing a "Chart of Inter-relationships", ref; WONDERLAND OF SCIENCE, BK. 7, p. 297, and SCIENCE PROBLEMS 1, (1951 edition) p. 350.

SUGGESTED ENRICHMENT ACTIVITIES

Essay: How Weather Changes Limit the Number of Plants and Animals (e.g. Penguins have no disease but . . .)

Research: Definition of "antibiotic" in simple terms.
Discovery of methods of producing penicillin, streptomycin, aureomycin. (Note: Scientists are experimenting further in the field of antibiotics. Watch for developments.)

Report: Proper attitude of boys and girls of today toward using rivers for sewage disposal, and reasons for adoption of this attitude.

UNIT VIII-3

WITHIN OUR SOLAR SYSTEM

Suggested Time Allotment: 4-5 weeks.

Purpose:

To develop an understanding of the earth's place in the sun's family.

Specific Objectives:

See understandings listed to the right of the suggested activities. Refer to pages 77 to 79 for skills, abilities, habits, and attitudes.

Suggested Approach:

Begin a class scrapbook of pictures and articles on the sun, planets, comets, and meteors.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major ideas)
Reading and reports: The students read for information about the sun and report their findings.	Compared with the earth, the sun is very large and hot.
Discussion: The characteristics of the sun (summarize main characteristics).	
Committees: Investigation of different theories about the "birth" of planets.	Man proposes different theories to try to explain the origin of the planets. (Other theories may evolve).
Charts: Wall chart showing relative sizes of planets and their distance from the sun. Chart showing time taken to reach the planets in a jet plane traveling at 1,000 miles per hour.	
Research and reports: Individual or committee reports on each of the planets under the following headings: (1) size, (2) position in the system, (3) length of day or period of rotation, (4) time of	The various members of the solar system are all different in several ways.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
revolution or length of year, (5) moons, (6) special features such as rings. *Report*: One student tells about planetoids. *Reading and discussion*: Famous meteors (shooting stars) that have "hit" our earth. *Essay assignment*: An Imaginary Trip to the Moon. *Teacher*: Discussion and presentation of phases of the moon; simple explanation of tides, using diagrams and pictures. *Writing*: Short science article on comets for the student's notebook. *Diagram*: The solar family showing a comet's path.	Comets come to our solar family now and again.

SUGGESTED ENRICHMENT ACTIVITIES

EXPERIMENT: Construction of a scale model of our solar system, using plasticine or other material. Students should try to estimate how far the nearest star would be with distances on the same scale as in the constructed model. (Although the planets are never all in line, the students might like to hang the planet models from a suspended string.)

Observation: Observation of sun spots with aid of heavily smoked glass.

Reading: For information on the possible effects on the earth of sun spots.

UNIT VIII-4

THE EARTH'S "COVER": WEATHER AND EROSION

Suggested Time Allotment: 6-7 weeks.

Purpose:

To have the pupils experience activities in relation to the earth's crust, so that they will have a better understanding of weather, soils, and erosion.

Specific Objectives:

See understandings listed to the right of the suggested activities. Refer to pages 77 to 79 for skills, abilities, habits, and attitudes.

Suggested Approach:

A directed reading assignment to discover why soil is so important to most forms of land life. Discuss such topics as: Above and below the timber line on mountains; soil-less agriculture; mosses and lichens; need of water, heat, and chemicals in soil.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major ideas)
Teacher: Trace the origin of soil from igneous rocks to loam and make a chart of the stages. *Class discussion*: Different ways rocks are broken down by the forces of nature. Students summarize the discussion. *Charts*: Picture chart for the scrapboard showing nature's forces in the process of soil-making. EXPERIMENT: Demonstration of the effect of heat on solids. (Ball and ring; heating suspended wire). EXPERIMENT: Demonstration of the effect of heat on liquids. (Expansion effect as applied to thermometers.) EXPERIMENT: Demonstration of the comparison of degrees of heat measured in Fahrenheit and Centigrade (use a thermometer graduated in both Fahrenheit and Centigrade.) *Research*: The students, making use of blackboard diagrams, learn how to change Fahrenheit readings to Centigrade, and vice versa (the students should not merely memorize a formula.) EXPERIMENT: The expansive force of freezing water.	Many forces combine to make soil.
Collection: Pictures mounted on the scrapboard showing the effects of nature's forces on rocks and soil. Different kinds of soil found in the local district; mounted and labelled clearly. EXPERIMENT: Demonstration of the fact that loam contains organic material. EXPERIMENT: Demonstration of ways in which soils differ: (1) weight per unit volume, (2) amount of water each type will hold, (3) relative time required for water to soak through each type. Clarification of the terms "light soil" and "heavy soil".	There are many types of soil.
EXPERIMENT: Demonstration of capillarity and its relation to the rise of water in the soil.	Most soil moisture comes from the air.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
EXPERIMENT: Demonstration of convection (heated air rises).	
Reading: The water cycle.	
Charts: The students draw charts to show the movement of moisture from large bodies of water to the air, and thence by condensation and gravity back to the ground.	
Research: A study of the hygrometer.	
EXPERIMENT: Demonstration of the measurement of moisture content in the air.	
Reading and reports: Evaporation, saturation, dew point, cloud formations, fog, types of precipitation.	
EXPERIMENT: Demonstration of the fact that air exerts pressure.	Variations in the temperature and pressure of the air cause weather changes.
EXPERIMENT: Construction of a mercury barometer.	
Research: Changing of sea-level barometric readings from centimeters to inches of mercury; finding the normal barometric reading for the local community.	
Report: Group report on the aneroid barometer and its advantages.	
Discussion: Teacher-led discussion on high and low pressure areas. (Use simple map diagrams; refer to the lamp chimney experiment.)	
Research: The students make a list of the chief instruments used at a weather station (students might make individual reports) possibly setting up a weather station and keeping records (make an anemometer and rain gauge; set out a thermometer and a barometer).	Man uses his knowledge of science to forecast the weather.

SUGGESTED ENRICHMENT ACTIVITIES

Reading: Torricelli's experiments with the barometer to discover how he used it to measure altitude.

Research: Discovery of how an aneroid barometer works; drawing the mechanism.

Writing: Paragraphs on cyclones, tornados and waterspouts.

Map work: A Mercator map of the wind systems of the world; include global diagram studies.

Written reports: Land and Sea Breezes; Monsoons; (suggested); Alberta's Chinooks; Sun Dogs; The Red Sunset; "Last Night the Moon Had a Golden Ring"; Canada's Meteorological Service; Weather Folklore; Weather Jingles: Rainbows.

UNIT VIII-5

ENERGY AND ITS USES

Suggested Time Allotment: 6-8 weeks.

Purpose:

To develop an understanding of the different forms of energy and how man has transformed energy to bring it under control.

Specific Objectives:

See understandings listed to the right of the suggested activities. Refer to pages 77 to 79 for skills, abilities, habits, and attitudes.

Suggested Approach:

A bulletin board collection of clippings which illustrates interesting forms of energy common in Alberta. The teacher should develop from these materials a definition of the word "energy", relating the term to work or motion.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major ideas)
Reading: Students read to find out about current views on the molecular structure of matter. *Discussion*: Based upon students' reading, and led by the teacher. *Group reports*: After research by groups, the group leaders report on each of the following forms of energy, giving clear examples of each. Heat; (molecular motion) Radiant; (heat, light, radio, cosmic waves in space) Chemical; organic or vital, inorganic Mechanical; (water wheel, windmill, mainspring of a watch, a baseball in motion, elasticity) Electrical; (and its relation to the energy of magnets.) Atomic; (the teacher might enlarge this heading in "enrichment activities")	There are several forms of energy.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
Reports: Students report, using diagrams, on various furnace systems, (hot air, steam, hot water) to show how the chemical energy of gas or coal is changing to radiant heat in the room of a house. *Research*: Trace the changes in forms of energy from the dammed water at Seebe, Alberta, to an electric toaster or range in an Edmonton home; trace the energy of a diesel locomotive back to the radiant energy of the sun; trace the heat and mechanical energy in our bodies to the food we eat. EXPERIMENT: Heating of ice to observe what happens when it changes from a solid to a vapor; particular observation of the temperature at which ice melts and boils.	Energy can be changed but cannot be created or destroyed. (This was a scientific law that was considered unchangeable; recent discoveries have caused the law to be questioned.)
Research: An attempt to find a way to measure the boiling point of water at reduced and increased pressures. *Discussion*: Teacher leads a discussion on how the principle, "boiling at reduced or increased pressure" is made use of in the following processes: (1) making condensed milk, (2) boiling eggs in mountain regions, (3) cooking in high altitude planes, (4) evaporation of brine, (5) pressure cookers, (6) oil refineries.	Boiling point and freezing point depend on pressure and temperature.
Teacher: Brief explanation of elements, compounds, mixtures, solutions. (Use sugar, water, sand, etc.) EXPERIMENT: Demonstration of conduction of heat in various materials. EXPERIMENT: Illustration of the process of distillation which includes evaporation and condensation; its relation to weather phenomena (rain, clouds, hail, dew, humidity, making rain by using dry ice.) EXPERIMENT: Demonstration of convection in air and water. EXPERIMENT: Demonstration of slow and rapid oxidation, (iron rust-	Energy is required to bring about physical and chemical changes.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
ing, silver tarnishing, a candle burning, a Bunsen burner in operation, magnesium ribbon burning). EXPERIMENT: Determining the "kindling temperature" of various materials. *Discussion*: How man speeds up and slows down the process of oxidation to suit his needs (stove with a good draught; painting a steel bridge). EXPERIMENT: Demonstration of chemical decomposition by heating sugar or salt in an old spoon. *Map work*: Students draw maps showing the possible sources of energy in Alberta (coal, oil, gas, timber, water power, tar sands). (The teacher should stress the idea of "resource conservation" as a preliminary to the fuller study of the subject in unit IX-4.) *Essay*: Short essay on "The Energy of Our Future World", or, "Energy Developments of Today Compared With Five Hundred Years Ago".	There are several undeveloped sources of energy in our province and elsewhere.

SUGGESTED ENRICHMENT ACTIVITIES

Reports: Famous men who have contributed to the development and use of the various forms of energy; e.g. Watt (heat), Franklin (electrical), Newton (mechanical), Edison (light), Lavoisier (chemical).
Interpretation of the statement, "Scientists stand upon the shoulders of their predecessors".

Reading: Reading, under the teacher's direction, about such possible future sources of energy as: the sun, tides, volcanoes, geysers, atomic power. (Students might like to make original or creative cartoons on these sources of energy).

UNIT VIII-6

THE PRODUCTION OF ELECTRICITY, AND ITS DISTRIBUTION IN THE HOME

Suggested Time Allotment: 6-8 weeks.

Purpose:

The purpose of this unit is to learn how electricity can be pro-

duced, and how we make use of it and control it in our homes in order to make our living more pleasant.

(Note: This unit consists mainly of experimental work).

Specific Objectives:

See understandings listed to the right of the suggested activities. Refer to pages 77 to 79 for skills, abilities, habits, and attitudes.

Suggested Approach:

1. The teacher may direct the building up of a blackboard chart. Sketch a house in miniature in the centre and label it "A Modern Electrified Home". From four directions (upper right, upper left, lower right, and lower left) draw four radial lines labelled thus: (1) Alberta Power, (2) Town Power from Coal, (3) Rural Power from Windchargers, (4) Future Atomic Power. Discussions might in every case start with Solar "Power", e.g. (a) Sun, Clouds, Rain, Rivers, Dams, Water wheels, Electricity for the home; (b) Sun, Plants, Animals, Coal, Steam, Engines, Electricity for the home. Atomic Power calls for no detailed discussion; in fact, a large question mark might be sufficient.
2. Review the topic of magnets and magnetism to establish foundation understandings for the study of electricity.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major ideas)
Assigned reading: Discovery of the ways in which electricity can be produced. EXPERIMENT: Construction of a cell to show that electricity can be made from chemicals. (A simple cell can be made by pushing strips of copper and zinc into a lemon, and connecting the strips with wires to a very sensitive current meter. It is more effective if the teacher uses nitric acid instead of the lemon. No attempt should be made to explain the chemical action involved). *Research*: Students take apart an old dry cell or flash-light battery to see how it is made. *Diagrams*: Students make diagrams of a dry cell; cross section, longitudinal section. (The battery is cut in two across the middle, and cut in two from top to bottom).	Electricity can be produced in several ways.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
EXPERIMENT: Demonstration of frictional or static electricity, using a comb, a fountain pen, a piece of fur, or a rug.	
Teacher: Tell the class about Franklin and his famous kite experiment. Relate the story to frictional electricity.	
Excursion: If possible the class visits an electric power plant and observes how electricity is made.	
Research: Finding out how electricity is made in a farm electrical plant; examining an old car generator to find the stationary or field magnets; also the spinning armature.	
EXPERIMENT: Discovering what happens when a bar magnet is pushed into and pulled out of a coil of wire. (Make several turns of wire to form a coil, and connect ends to a sensitive current meter).	
Reading: Discovery of the way in which water, steam, wind, and exploding gas are used to make electricity by turning the shaft (armature) of generators.	Electricity is used to produce motion in an electric motor.
Assigned textual reading: Discovery of the ways in which electricity is used.	
Research: Construction of a simple electric motor and description of the way in which it works. Comparison of this simple motor with a toy electric motor brought from home.	
Lists: Girls list household appliances which have electric motors.	
Writing: As an alternative to the above, girls write an essay on "How Electricity Has Made Housework Easier".	
EXPERIMENT: Students test different kinds of materials for their insulating qualities.	Conductors "carry" electricity; non-conductors or insulators do not.
Research: Finding out the different kinds of insulation used in the home.	
Servicing and repair: Repairing a broken electric light socket or a broken elec-	

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
tric light plug; learning proper way to splice electric wire and make electrical connections. (The students should be able to answer the following question: Why is a frayed electric cord dangerous?)	
EXPERIMENT: Setting up an electric circuit using a switch, some wire, a small flashlight bulb, and a dry cell.	Electricity flows by the shortest complete path.
EXPERIMENT: Producing a short circuit at a point nearest the dry cell by baring the wire in a circuit which includes an electric light. (Students should know why a short circuit is dangerous.) Examining a house fuse and a car fuse by breaking them carefully with a hammer. Placing an electric light fuse in a circuit so that it acts as a switch. Heating a piece of fuse wire with a match. (The students should be able to explain clearly the function of a fuse).	
Service and repair: Students learn the correct method of putting a new fuse in the switch box in their homes. (Students should know why a coin or bent nail should not be used in place of a fuse. Girls should learn why a frayed electric iron cord may be dangerous). (Students should also know that replacing a burned out car fuse with a piece of lead foil is not a safe practice.)	
Research: Examination and recognition of various types of electric switch; e.g. toggle, snap, blade, push button, silent switch. Finding out how the ignition key in a car acts as a switch; discovery of the way in which electricity is conducted through the screw-in base of an electric light bulb. (The base should be carefully broken.)	Electricity is a good servant of man.
Diagrams: Students make neatly labelled diagrams in their note books of the structure of a light bulb.	
Written assignment: Essay on "The Benefits of Electricity to Modern Life".	

SUGGESTED ENRICHMENT ACTIVITIES

Experiment: Learning about lights "in series", and "in parallel", by experimenting with Christmas tree lights.

Mural: The history of lighting from primitive times to the present

Research: If possible the student obtains an old light meter in order to study the gearing and to learn how to make readings; how power is paid for by the consumer (a study of kilowatt-hours).

Group work: Interested students make an "electrical board" or panel with motor, lights, fuses, transformer (if necessary) dry cells, switches, etc., on it.

Service and repair: Girls learn how to connect properly wires to a light socket; also learn why housewives should be careful not to overload a circuit.

Research: Discovery of the meaning of "combination" electric power rates in the home.

CHAPTER VII

UNIT STUDIES FOR GRADE IX

SPECIFIC OBJECTIVES FOR GRADE IX UNIT STUDIES

A specific objective is a single aim or goal which gives direction to some phase of learning in a particular unit study. As the teacher plans and works out the unit studies with the students, he should consider how the general objectives (discussed in Chapter 2) are translated into action by means of specific objectives. Specific objectives state in more or less exact terms the results that may be expected from the particular unit of work. Since they are stated in terms of pupil behavior or pupil experience, the evaluation of student effort and performance should be made in terms of these specific objectives.

The specific objectives for this course of study are divided into three main groups: (1) Understandings, (2) Skills, Abilities and Habits, and, (3) Attitudes.

(1) *Understandings*: These will be found in the right-hand column of the unit study outlines. Each understanding appears opposite the suggested activities which are considered best suited to develop that particular understanding.

(2) *Skills, Abilities and Habits,* and (3) *Attitudes*: Examples of these two are listed below. Since these examples apply to all the units of the Grade IX course, it was thought best to place them all together, previous to the study outlines, rather than to give a complete list of specific objectives for each unit. For each specific objective listed below, illustrations of activities, taken from one or more of the Grade IX units, are given to show how these activities contribute toward the attainment of the specific objectives. It should be noted, however, that these are merely illustrations and that each specific objective will apply to activities in units other than those indicated or to other activities within the same unit.

SKILLS, ABILITIES, AND HABITS

Students are expected to develop appropriate skills, abilities and habits in the following areas:

A. Graphic Arts (Making and interpreting charts, maps, diagrams and simple illustrations)

Examples: Unit IX-1: making a booklet on irrigation.
Unit IX-2: three generations of sweet peas.
Unit IX-5: hydro-power dams.
Unit IX-3: time-telling devices from ancient to modern times.
Unit IX-5: a chart showing the development of land, sea, or air transportation.

Unit IX-1: map of world grain area.
Unit IX-3: latitude and longitude.
Unit IX-4: Alberta's rainfall, erosion control in relation to topography.
Unit IX-5: power sites in Alberta, the electric refrigerator, pumps.

B. Communication (Oral and written expression)

1. Summarizing a discussion for permanent record purposes:
   Examples: Unit IX-1: value of Alberta's animals.
   Unit IX-4: waste of mineral resources.
   Unit IX-5: gasoline versus steam engines.
2. Organizing and presenting oral reports:
   Examples: Unit IX-1: grains.
   Unit IX-2: control of the environment.
3. Understanding clearly, and spelling correctly, words used in science: e.g. Unit IX-4, "contour", "training", "erosion", "reforestation".
4. Expressing ideas in a simple paragraph: e.g. Unit IX-4: Dustbowls; Christmas tree traffic.
5. Organizing ideas for an essay:
   Examples: Unit IX-1: The Horse is Canned.
   Unit IX-2: The Development of the Boysenberry
   Unit IX-4: Forest Protection.
   Unit IX-6: The Air-liner.
   Unit IX-6: The Telephone.
6. Listening attentively to oral reports by pupils or to a teacher-presented lesson:
   Examples: Unit IX-1: a teacher-directed summary of Alberta's economic animals.
   Unit IX-5: the operation and control of the airplane.
   Unit IX-6: a doctor talks on the X-Ray.
7. Argument and debate:
   Examples: Unit IX-3: Daylight Saving in Alberta.
   Unit IX-4: Machines versus Man.
   Unit IX-5: Atomic Power; Our Tragic End or Fruitful Beginning.

C. Reading

1. Reading and re-reading for understanding.
2. Skimming for information.
3. Using the index and table of contents in searching for information.
4. Using the resources of the library.
   Examples: Unit IX-1: history of wheat varieties.
   Unit IX-2: plant diseases.
   Unit IX-4: tourist data.

D. Organizing Materials (Collecting, selecting and arranging)

Examples: Unit IX-4. tourist attractions in Alberta.
Unit IX-1: grain and weed seeds.

E. Use of the Scientific Method

1. Arriving at general conclusions from many specific examples: e.g. Unit IX-4: results of forest depletion.
2. Using the scientific method: e.g. Unit IX-3: demonstration to show causes of eclipses.

F. Experimental Work

1. Manipulating laboratory equipment.
2. Interpreting experimental phenomena.
3. Writing reports on experiments.
4. Using caution in dealing with dangerous materials.

Examples: Unit IX-4: erosion.
Unit IX-5: levers; jet propulsion.
Unit IX-6: electrical conduction.

G. Social Relationships

Leading and following in committee work:

Examples: Unit IX-1: Alberta's weeds.
Unit IX-2: breeds of animals.
Unit IX-4: game protection.
Unit IX-6: uses of electric motors.

H. Mechanics

Examples: Unit IX-3: making a sun dial and a home-made sextant.
Unit IX-5: making airplane models.
Unit IX-6: making a wind charger.
Unit IX-6: learning to service and repair simple household appliances, such as the proper oiling of mechanical and electrical machinery, and caring for a storage battery.
Unit IX-6: using caution in handling mechanical and electrical equipment; short circuits, X-Rays, leaving an electric iron turned on, etc.

I. Mathematics

Solving mathematical problems which arise in science.

Examples: Unit IX-3: circular measure, longitude and time.
Unit IX-5: mechanical advantage of machines. foot-pounds, horsepower.

ATTITUDES

Students may be expected to show improvement in the following behavior traits.

1. **Self-respect: through continued work on a unit study in the face of difficulties or distractions:**
   e.g. Unit IX-1: collecting grain seeds and carefully mounting them.

2. **Creativeness:**
   e.g. Unit IX-1: graph studies, and soil maps, in color—Unit IX-5: making a model 'plane.

3. **Scientific Attitude:**
   (a) open-mindedness: e.g. Unit IX-5: critical thinking in connection with all the implications of irrigation projects in Alberta—considering the values and dangers from the building of hydro-power dams.
   (b) Acceptance of cause and effect in the physical world: e.g. Unit IX-3: the seasons; Unit IX-5: how an electric light bulb is lighted by the sun; Unit IX-6: why a percolator "perks".
   (c) Scientific enquiry: e.g. Unit IX-5: a desire to learn about jet rockets; Unit IX-6: a desire to know how the "electric eye" works.
   (d) Suspended judgment: e.g. Unit IX-5: source of energy in the atom—whether or not we can reach the moon.

4. **Cooperation: through tolerance and respect for other people's opinions:**
   e.g. Unit IX-5: a discussion of how the development of energy affects the distribution of jobs—a discussion of a longer or shorter work-week.

5. **Responsibility: through meeting of one's obligations:**
   e.g. having reports ready, or getting essays in on time.

6. **Social Concern: through showing an interest in the growth and progress of all class members:**
   e.g. Unit IX-1: interest in a grain or calf club.

7. **Reverence: through respect and admiration for:**
   (a) the method used by the scientist; e.g. Unit IX-2: having faith and confidence in such experimental work as the development of new plant varieties to suit special adverse conditions.
   (b) the work of the scientist in the past: e.g. Unit IX-2: the work of Mendel and Burbank; Unit IX-5: the contributions of Ford and Stephenson; Unit IX-6: the discoveries of Roentgen.
   (c) Nature's gifts and the need to conserve them: e.g. Unit IX-4: conservation of our natural resources and the fact that they are not inexhaustible; Unit IX-1: the fundamental value of soil to man's existence.
   (d) the value of agriculture to all people regardless of occupation: e.g. Unit IX-1: grains have always been a major source of man's food supply.

UNIT IX-1

PLANTS AND ANIMALS BASIC TO ALBERTA'S AGRICULTURE

Suggested Time Allotment: 7-8 weeks.

Purpose:

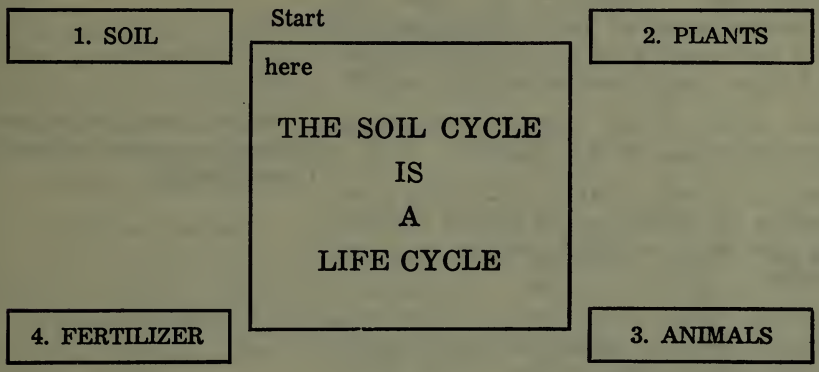
To develop an appreciation of the economic importance of plants and animals in Alberta's agriculture at the present time.

Specific Objectives:

See understandings listed to the right of the suggested activities. Refer to pages 95 to 98 for skills, abilities, habits, and attitudes.

Suggested Approach:

A diagram and discussion study.



(a) The teacher will introduce the overall idea of the cycle; SOILS⇒PLANTS⇒ANIMALS⇒SOIL.

(b) Carry the discussion back to the time of primitive man to show that the hunter, farmer, and herder depended on this same cycle.

(c) Show that even in our highly mechanized age of today, all Alberta's people, as well as the entire population of the world, depend on the cycle.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major ideas)
Part I: Soil and Plant Studies	All life on the earth is dependent upon soil.
Discussion: Various types of soil found in Alberta and comparisons of advantages of each type. (e.g. sandy loam, gumbo).	
Note to teacher: The detailed study of soil, its formation and conservation is treated in Units VIII-4 and IX-4.	

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
Map work: Soil map of Alberta, distinguishing the different soil areas by means of colored crayon. (The teacher should stress the fact that soil areas are "life" areas).	
Reading: Discovery of the ways in which soils can be made more fertile in order to increase productivity. (Refer to natural fertilizers such as green manure, animal manure, and legumes; also to artificial fertilizers such as phosphates). Discovery of how the mineral content of soils determines the kind and quality of crop grown (refer to forage, grain, and vegetable crops).	
Map work: World map of the grain-growing areas of the globe.	Grains have always been a major source of man's food supply.
Graphs: Circle graph comparing production of wheat in the major producing countries—similar graphs for other grains.	
Reading: For information about the history of early wheat varieties grown in Western Canada (Red Fife, Marquis).	
Research: Information on new varieties and why they have been developed; information on areas in Alberta where winter wheat is, and why; information on the different uses of hard and soft wheat (bread, pastry, macaroni).	
Graphs: A bar graph showing the amount of wheat production in Alberta in ten-year periods since 1900.	
EXPERIMENT: Test of germination of wheat,oats, and barley.	
EXPERIMENT: Testing wheat for "gluten" (protein) by chewing grains. Discussion of the protein content of wheat grown in Western Canada and why this is important to world trade.	
EXPERIMENT: Testing bread for starch (iodine test).	

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
Reports: Areas in Alberta where oats, barley and alfalfa are grown: discovery of why these grains are grown (discussion of such factors as frost, soil quality, relationship to rotation, uses, etc.).	The raising of crops other than wheat is also important to the people of Alberta.
Research: Learning to identify other grains grown in Alberta.	
Class discussion: Irrigated crops in Southern Alberta with special reference to sugar beets.	
Essay: Irrigated crops in Southern Alberta.	
Collection: Grain seeds, (use vials and mount and label carefully) (one collection per room or school).	
Research and report: Group study of Alberta's noxious weeds and their control; report on findings.	
Part II: Animal Studies	
Research: Discovery of the animals raised in Alberta for food; comparison of relative importance of each.	Animals are a major source of human food.
Reports: Uses of Alberta's animals for wool and leather.	Animals provide us with clothing and other things. There are several kinds of animals important to Alberta's agricultural economy.
Research and report: Class divided into groups, each group reporting on one of the following topics: 1. Dairy breeds of cattle. 2. Beef breeds of cattle. 3. Important breeds of hogs raised in Alberta. 4. Farm and range breeds of sheep. 5. Poultry breeds raised in Alberta.	
Excursion: To a livestock center.	
Talk: By a live-stock expert to the class.	
Collections: Pictures for the scrapboard on each of the following groups of animals: 1. Poultry. 2. Fur-bearing animals. 3. Sheep. 4. Swine. 5. Cattle. 6. Horses.	

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
Essay: The Future Economic Importance of the Horse, or, The Horse is Canned. *Summary activity*: The teacher may organize a careful blackboard summary under the following headings: 1. Number of animals produced in Alberta and their cash value. 2. How international markets and prices affect production of beef and hogs in Alberta. 3. World production and export of wheat.	Food plants and animals have a high economic value in the life of the people of Alberta.

SUGGESTED ENRICHMENT ACTIVITIES

EXPERIMENT: Making a protein test for meat and grain (nitric acid to be used with care)

EXPERIMENT: Testing for starch in grains.

EXPERIMENT: Testing for fats in meats, grains and nuts (grease spot test on paper).

Reports: Grain, calf, or swine club members give a report on their work to the class.

Research: brief studies of fruit-growing, flower-raising, bee-keeping. Demonstration of the fact that the soil cycle diagram in the suggested approach to this unit is a combination of two other cycles, the carbon cycle and the nitrogen cycle.

UNIT IX-2

NATURAL AND ARTIFICIAL IMPROVEMENT OF ECONOMIC PLANTS AND ANIMALS

Suggested Time Allotment: 4-5 weeks.

Purpose:

To show the importance of natural plant and animal selection through the ages, and to show man's application of the scientific method to improve economic plants and animals.

Specific Objectives:

See understandings listed to the right of the suggested activities. Refer to pages 95 to 98 for skills, abilities, habits, and attitudes.

Suggested Approach:

A brief class discussion on the high standards set by our Canadian wheat and bacon in the markets of the world.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major ideas)
Reports: Varieties of grains, forage crops, and vegetables grown in the local district. Reasons should be given why such selection has been made (e.g. Saunder's wheat, Olli barley, kinds of sugar beet, white or yellow sweet clover, Netted Gem potatoes); beef and dairy breeds of cattle, and poultry breeds raised in the local districts; why these choices were made (e.g. Hereford, or Jersey cattle, Merino sheep, Yorkshire hogs, White Leghorn Chickens; basis here is mainly on consumer demand).	Selection of plant varieties and animal breeds by the producer are based on soil and climatic conditions, and on consumer demand.
Lists: Students list the qualities and standards desired by the consumer in some of the following: potatoes, apples, milk, poultry, etc.	
Research: Investigation of standards used in selling canned vegetables and fruit, butter, eggs, meat, etc.	
Oral reports: Steps taken by man to overcome the following adverse factors affecting plants; drought, frost, low soil productivity, weeds, rust, (Thatcher wheat), smut (treatment with chemicals), saw-fly (Rescue wheat) etc.	Plant varieties are developed to overcome adverse climatic conditions and parasites.
Note: Avoid detailed reports.	
Teacher: Outline of evidences of natural changes and selection in plants and animals through the century. (Very brief reference to studies made by Darwin.)	Natural improvement in plants and animals has been a long and continuous process.
Research: Contrasting several modern domesticated animals with their ancestors.	
Reading: Finding out the importance of natural selection, "freaks", and inheritance in the natural improvement in the species.	
Reading: Experiments performed by Mendel and Luther Burbank.	Scientific methods have been used to improve plants and animals artificially.
Research: Students select their own examples of dominant and recessive characteristics in plants, animals and people.	

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
Charts: Three generations of hybrids. *Research*: Discovery of meaning of hybrid plants and animals. *Discussion*: Advantages and disadvantages of hybrid forms (e.g. mule, hybrid corn). *Research*: Discovery of meaning of the following terms as applied to the improvement of plants and animals: grafting, budding, inbreeding, crossbreeding, grading up, dominant, recessive. *Essays*: Artificial Improvement of Plants. Artificial Improvement of Animals (example of the latter is the development of the English and American race horse). *Writing*: Paragraphs on a specific "hybrid" topic such as; The Development of the Boysenberry, The First Production of a Grapefruit, When the Apricot First Appeared.	

SUGGESTED ENRICHMENT ACTIVITIES

Essay: The Life Work of Luther Burbank.

Reading: Discovery of how inbreeding and artificial selection were used to develop one of the following breeds; Hereford cattle, Polled Angus cattle, Jersey cattle, Percheron horse.

Scrapbook: Planning a well organized scrapbook in two main sections: Plants and Animals. (Material should be confined to domestic varieties.)

UNIT IX-3

THE EARTH'S MOVEMENTS AND HOW THEY AFFECT US

Suggested Time Allotment: 4-5 weeks.

Purpose:

To develop an understanding of the rotation and revolution of the earth, and how these movements are related to day and night, seasons, eclipses, tides, and time-telling.

Specific Objectives:

See understandings listed to the right of the suggested activities. Refer to pages 95 to 98 for skills, abilities, habits, and attitudes.

Suggested Approach:

Make a summary in chart or outline form of various time-telling devices from ancient to modern times, and discuss the news-flash: "Man arrives in San Francisco five minutes before he leaves New York."

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major ideas)
EXPERIMENT: The causes of day and night (use diagrams, globe or models).	The earth rotates on its axis, causing day and night.
EXPERIMENT: Demonstration that a vertical ray of light covers less area than a slanted ray (use a flashlight and a globe or basketball in a darkened room).	The earth revolves around the sun at an angle to the plane of its orbit, causing the seasons.
EXPERIMENT: Demonstration of the cause of seasons (use diagrams, globe, or models).	
Research: To find answers to the following questions: Why do lengths of days and nights vary throughout the year? Why do temperatures vary throughout the year? What changes would take place in our seasons if the earth's axis had no "tilt"? if it had a greater "tilt" than now exists?	
EXPERIMENT: Demonstration of the way in which lunar and solar eclipses take place.	Eclipses are caused by the obstruction or blocking off of light coming to the earth.
Diagrams: Students make diagrams of eclipses in their notebooks.	True solar time is based upon the rotation and revolution of the earth.
Research: Why did early man need to tell time? How did man tell time in bygone days? Why is time-telling important to everyone today?	
Teacher: Review circular measure (degrees only).	
EXPERIMENT: Discovery of latitude and longitude on globes and world maps (it should be made clear that in "true time", every point on an east-west parallel of latitude has a different time, and that if this principle were strictly applied, the result would be confusing and impractical).	

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
Research: Locating and naming the standard time belts on a map of Canada. *Teacher*: Prepare for the class simple problems on longitude and time (time differences between the student's home locality and London, Eng., Toronto, Honolulu, etc.; "When it is noon by your watch, is it noon by the sun? explain").	The earth is divided into convenient time belts or zones.

SUGGESTED ENRICHMENT ACTIVITIES

Research: Discovery of how an electric clock keeps accurate time (timing of electric "cycle").

Reading: The meaning of the International Date Line.

Research: Discovery of the purpose of leap year; reason why air navigators wear two watches on their wrist(most of them do; one watch shows standard time, the other Greenwich time) ; the change in time on crossing the International Date Line from east to west and from west to east.

UNIT IX-4

CONSERVATION OF EARTH'S RESOURCES

Suggested Time Allotment: 5-6 weeks.

Purpose:

To learn that our resources are limited and that conserving them is a personal as well as a group responsibility.

Specific Objectives:

See understandings listed to the right of the suggested activities. Refer to pages 95 to 98 for skills, abilities, habits, and attitudes.

Suggested Approach:

Draw a map of Alberta, carefully marking the following: forest areas, oil and gas regions, coal mining areas, and tar sand deposits.

Or, using the Canada Yearbook, find the value of Alberta's production of forest products, petroleum products, coal, and wheat, in any recent year. Show these on a bar graph.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major ideas)
Teacher: Define conservation and review the factors which cause weathering and erosion. EXPERIMENT: Demonstration of soil erosion and effects of control. Procedure—place sod (top soil and fibre) in one box, and loose, fine top soil in another. Expose both to the wind or the breeze from a fan. Measure soil change by means of an implanted ruler. Next, place stubble or grass on the loose, fine top soil and repeat experiment. (What is the importance of the "Noble Blade" in relation to soil erosion?) *Class discussion*: Various methods of controlling wind erosion by cultivation and cropping (include strip farming, contour cultivation, cover crops, planting grass, tree windbreaks, etc.) EXPERIMENT: Demonstration of how running water forms gullies and washes away top soil. *Reports*: Committee reports on methods of preventing water erosion (include contour farming, cover crops, strip cropping, terracing, grass crops, basin listing, tree planting, etc.) *Teacher*: Indicate how minerals in the soil may be depleted by water erosion (leaching) and by successive cropping. Show how this condition may be corrected by crop rotation and artificial fertilizing. EXPERIMENT: Observation of mineral content of soil. Procedure: fill a tumbler half full of rich loam and then fill with rain or distilled water. Mix well and leave for half an hour. Filter water into a beaker. Boil until water is vaporized, leaving a mineral deposit in the beaker. *Map work*: Students prepare an outline map of Alberta, marking in the rainfall distribution by different shadings.	Erosion by wind and water is a serious problem in Alberta, but it can be controlled.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
Lists: Students make a list of some of the important uses of Canadian lumber. *Reading*: Information on annual loss by forest fires in Canada (students should be able to suggest how these losses occurred). *Discussion*: Steps taken by the government to prevent forest fires. *Writing*: Article on one of the following: Reforestation, Controlling Insect Pests in Timber Stands, Protection of Forests and National Parks. *Research*: Discovery of what happens to the following when the forests are depleted: level of the water table, river levels in spring, soil erosion, balance in nature, cost of home building. *Writing*: Paragraph on "The Tragedy of Christmas Tree Traffic".	Timber losses can be reduced.
Teacher: Leads a discussion to show that our mineral resources are limited (references to specific minerals such as petroleum and natural gas). *Lists*: Students list ways in which we waste our mineral resources. *Research*: Discovery of the relative importance of Alberta's oil industry to: Alberta, Canada, the world. *Reading*: Future sources of fuel. *Writing*: Brief essay on "Resources: Quickly Consumed But Slowly Replaced".	The supply of our mineral resources can run out.
Lists: Numerous animals in Alberta's wild life; explanation of value of each. *Oral report*: Student tells about a visit to a fish hatchery and explains what is done with the fish. *Research*: The way in which fish, going up or down stream get past big dams. *Committee reports*: Buffalo parks; protection of wild life in national parks; Ducks Unlimited; Fish and Game Associations; government regulations regarding open and closed seasons on game; the duck invasion of grain fields; big game hunting.	

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
Teacher: Leads a discussion to list factors which lure tourists to Alberta (e.g. advertising, good roads, accomodation and meals, scenic beauty, fishing, hunting, sport facilities, western hospitality, tourist bureaus)	Tourist trade is a significant Alberta resource.
Writing: Paragraph on "Science Lengthens Man's Life".	Man is learning how to conserve his human responsibility.
Class discussion: "In our Machine Age the Five Day Week Seems Near"; suggest valuable and worthwhile ways for people to relax and use their leisure time.	

SUGGESTED ENRICHMENT ACTIVITIES

Collections: Picture for a scrapbook to illustrate the results of wind and water erosion. (The same scrapbook may be used to show timber losses from fire, oil and gas wastage, mineral wastage, loss of wild life, and wastage of human resources.)

Research: Information on the number of tourists who yearly enter our national parks, where they come from, and the yearly revenue they bring to Canada.

Collections: An attractive booklet or scrapbook of scenes in the mountains of Alberta.

UNIT IX-5

MACHINES AND THEIR SOCIAL IMPLICATIONS

Suggested Time Allotment: 7-8 weeks.

Purpose:

To develop an appreciation of our machine age as well as a knowledge of some of our basic machines.

Specific Objectives:

See understandings listed to the right of the suggested activities. Refer to pages 95 to 98 for skills, abilities, habits, and attitudes.

Suggested Approach:

Compare and contrast modern living in our mechanized America with that found in the backward and primitive regions of Asia.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major ideas)
Teacher: Review scientific definition of work and energy. List a number of different forms of energy.	Six simple machines help man to do his work.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
Lists: Students make a list of machines stating the form of energy each uses and the form of energy each gives out (e.g. a water turbine and generator change the energy of moving water, i.e., mechanical energy, to electrical energy.)	
Research: Discovery of the meaning of friction, gravity, inertia; explanation of how each affects the "ability to do work".	
EXPERIMENT: Demonstration of the mechanical advantage of each of the three types of lever (Law of Levers).	
EXPERIMENT: Calculation of the mechanical advantage of various pulley combinations, using a weight and spring scale (balance); discovery of the mechanical advantage of the wheel and axle.	
EXPERIMENT: Demonstration that the screw is an inclined plane, using a triangular piece of paper wrapped around a pencil.	
EXPERIMENT: Determining the mechanical advantage of various inclined planes; demonstration that the wedge is a double inclined plane.	
Research: Examination of some selected complex machine (e.g. crane, lawn mower, sewing machine) to show that it is really a combination of the six basic machines.	
Diagrams: Lift pump, force pump, rotary pump (centrifugal pump).	
EXPERIMENT: Determining how pumps work, using models.	Liquid or gas pressure is used in certain machines.
Research: Examination of an old rotary car water pump to find out how it is constructed. (An electric motor could be used to show that it pumps water.)	
Diagrams: Diagram of the air pump with an explanation of how it works.	
List: The uses of the air pump.	

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
Reading: How some machines work by drawing air out, (e.g. vacuum cleaner, milking machine). *Report*: Examples of hydraulic presses in common use. *Diagrams*: The hydraulic press showing how it is able to exert force. *Problem solving*: Calculation of the mechanical advantage of various presses.	
Discussion: Why people perspire freely on a hot day. *Research*: Students find out how artificial ice is made for hockey and curling rinks, and for making ice to sell in blocks for ice refrigerators.	Liquids require heat to change them to a gaseous state.
Reading: Discovery of the meaning of the terms: foot-pound, horse power, kilowatt. *Research*: Determining how power is calculated. *Diagrams, models*: Different types of water wheel showing how each works; diagram of a hydro-power dam and plant. *Map work*: Location on a map of Alberta of the developed water power sites in our province. *Report*: Possibly a student could report on his visit to a hydro-power dam.	"Stored-up" energy can do important work for man.
Diagram: Cross-sectional diagram of a steam engine with explanation of its operation (stress combustion outside the engine); study of cross-sectional views of what goes on in a gasoline or diesel engine (stress combustion inside the engine) *Summarize*: Points of contrast between a gasoline engine and a diesel engine.	
Reading: A history of the automobile which shows the application of the principle of scientific experimentation and how modern machines came from humble and crude beginnings. (Class members might tell stories about the lives of Henry Ford, George Stephenson, Diesel and others.)	Science moves the wheels of progress.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
Research: Finding out the advantages and disadvantages of coal-or oil-burning locomotives, diesel-electric, and gas turbine locomotives; comparison of Stephenson's "Rocket" with a modern locomotive; the date of Stephenson's invention.	
Teacher: Explanation of the terms "lift", "drag", "thrust", and "gravity" as applied to the airplane.	
Research: Explanation of the function of a propellor.	
Reports: Boys might bring model 'planes and explain how they fly.	
Reading: Finding out the precautions aviators have to take in flying at high altitudes.	
Writing: Short story, telling of a trip in a modern airliner.	
EXPERIMENT: Demonstration of jet propulsion by blowing up a balloon and releasing it so that the escaping air forces the balloon in the opposite direction.	
Teacher: Explanation that rockets and jet engines operate on the principle that large quantities of gas escaping rapidly force the rocket or jet engine forward.	
Discussion: "Why might rockets be used as 'space ships', but not 'jets'?"	
Report: "The value of jets to future air travel"; description of an imaginary trip to the moon or to a nearby planet.	
Lists: Several social benefits and social dangers that might result from man's use of atomic energy or power.	The world's future social and economic development may depend upon man's wise control of atomic energy.
Discussion: How the further development in man's use of energy will affect (1) man's weekly hours of work, (2) man's leisure, (3) distribution of jobs among people.	
Writing: Essay on "Machines, Men, and Jobs."	

SUGGESTED ENRICHMENT ACTIVITIES

Research: Finding out how hydraulic brake system of a modern car works; how the hydraulic lifts on modern farm machinery work.

Reading: For information on how an electric refrigerator works.

Research: Estimating the part jet engines will play in rail and ocean travel.

UNIT IX-6

ELECTRICITY IN OUR DAILY LIVING

Suggested Time Allotment: 6-7 weeks.

Purpose:

To help students realize the many ways in which electricity has transformed our modern living.

Specific Objectives:

See understandings listed to the right of the suggested activities. Refer to pages 95 to 98 for skills, abilities, habits, and attitudes.

Suggested Approach:

A combined picture and blackboard-summary discussion contrasting the modern home with the pioneer home of one hundred or two hundred years ago. Deal with such electrical conveniences as those advertised in catalogs, magazines, and newspapers.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major ideas)
Observation: Temperature differences caused by the flow of electricity from a dry cell along various kinds of wire (use copper, iron, steel, and nichrome wire). *Teacher*: Review with the class the factors which determine the amount of heat produced from the flow of electric current (current strength, type of conductor, cross-sectional area of the conductor, length of conductor). *Research*: Examination of an electric iron and the thermostatic controls on it; examination of an electric toaster to show that it is a "resistance heater"; the students should attempt to discover the principle of the "pop-up" toaster;	The principle that electricity will flow easily along some conductors and less easily along others (resistance effect) is used in many home appliances.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
procuring advertising material to discover how an electric range works; finding out how block heaters for cars are installed, and explanation of why they are easily and safely maintained as compared with other methods of heating; discovery of the way in which a thermostatically controlled water heater works; (students should be able to tell why natural gas heaters can compete with electric heaters in Alberta and elsewhere; they should also be able to tell why electric fire places and radiant heaters, while convenient, are not really economical); finding out how electric welding machines work; finding out about some of the following: coffee percolators, hair dryers, electric heating pads, baby-bottle heaters, car heaters for outdoor theatres, heated clothing for high altitude flyers.	
Reading: Finding out how incandescent lamps are made (hot light); interpretation of the markings on electric light globes. *Discussion*: Various uses of incandescent lamps (home, street, camera, cars, searchlights, floodlights); uses of flourescent and neon lighting (cold light). (Features: low pressure, vapor, high voltage); direct, indirect, and concealed (or recessed) lighting in the home of today. *Reading*: Ultra-violet light; sun tan, vitamin D; use of ultra-violet light in sterilizing medical instruments, healing wounds, and possible future use in killing germs in air conditioning units.	Electricity can be used to produce light and special rays.
Discussion: (Based on directed reading in or out of class). To discover that electric motors make things work (vacuum cleaner, mixmaster, electric clippers and shaver, lawn mower, clock, floor polisher, washing machine, dishwasher, shop tools, garbage disposal grinder, sewing machine, trolley cars and busses, refrigerator, fan, etc.)	Motors run by electricity may be used to suit a variety of our needs.

SUGGESTED ACTIVITIES (Content of the unit)	UNDERSTANDINGS (Major Ideas)
Research: Finding out how the telephone transmitter and receiver work. (The teacher should explain briefly the elementary principles of sound transmission); discovery of points of similarity between the telephone receiver and the radio loud speaker.	Electricity makes possible rapid communication.
Writing: Essay on stories of the telephone, telegraph, submarine cable, radio microphone (these may be subjects for murals or friezes rather than essays).	
Map work: Drawing a map of Alberta's electric power lines.	Rural electrification makes farm life easier and more attractive.
Research: Finding out how gasoline and diesel electric plants work (voltage usually 32V)	
Construction: Model of a wind charger.	
Research: Finding out how storage batteries are used in farm units; relation of storage batteries to a wind charger (16 cells of 2 volts each).	
Research: Tearing down an old battery to examine the "insides". (The storage battery consists of three units of two volts each; English cars have twelve-volt batteries).	

SUGGESTED ENRICHMENT ACTIVITIES

Research: Discovery of how a shoe-fitting "ray machine" works; how an electric eye is used for rapid counting, for opening doors, for working a burglar alarm, for running a robot machine.

Reading and report: Roentgen's famous work on X-rays.

Research: Method of testing materials for hidden flaws (X-rays to test metals); methods of discovering contraband (X-ray used by customs officials to detect concealed articles such as gold in heels of shoes.)

CHAPTER VIII

EVALUATION OF STUDENT GROWTH IN RELATION TO SCIENCE STUDIES

Evaluation is essentially the collecting and recording of information pertinent to behavior of the student. As such it involves all of the methods and techniques for gathering evidence about student growth. The main difference between evaluating and testing is that evaluation attempts to assess the total behavior of the student while testing can only measure his mastery of subject matter.

The purpose of evaluation is to determine the extent to which the student is achieving the specific objectives of the units. No longer should teachers think narrowly of merely testing either the results of unmotivated busy work or mastery of subject matter. Evaluation, in any form, should serve three main purposes: (1) indicating the effectiveness of instruction, (2) providing information on individual needs, and (3) furnishing a basis for good public relations with parents.

Evaluation in the science program must reflect the philosophy of the course. Science instruction in this program is problem centered. While the content material of the program is still important, subject matter becomes a means or avenue to student development rather than an end in itself. Quillen and Hanna indicate the fallacy of measuring only the mastery of factual information. They state:

> "If the sole obective of instruction were the acquisition of facts and skills on the part of the student, education . . . would have to be pronounced a failure, for objective evidence proves that few of the facts which boys and girls learn are retained after they leave the classroom."

Evaluation in the science program must reflect the objectives of the course. The specific objectives of the course, listed at the beginning of each of the grade unit studies, are stated in terms of desired improvement in student behavior. The unit studies for Grade VII, VIII, and IX provide situations in which student behavior may be actually observed and evaluated in terms of desired behavior as set forth in the specific objectives. The improvement of behavior should be continuous; evaluation should therefore provide a continuous record of the progress of the student in the improvement of skills, habits, abilities, attitudes and understandings.

ASPECTS OF BEHAVIOR OR LEARNING REQUIRING EVALUATION

It should be understood that there is no single appraisal technique which adequately measures all aspects of student growth

and experience. There are four major areas of learning which require evaluation: (1) facts and information, (2) understandings, (3) skills, abilities and habits, and (4) attitudes.

(1) *Facts and information*: These are usually evaluated by paper-and-pencil tests. The best test of this kind is one in which the facts and information require to be recalled in order to support an understanding. In other words, the test should stress logical recall of facts and information.

(2) *Understandings*: These may be evaluated by means of paper-and-pencil tests which aim to measure the use of facts and information, the application of scientific principles to daily living, and the ability to draw conclusions and make general izations.

(3) *Skills, abilities and habits*: Effective individual growth in skills, abilities and habits may be evaluated by direct observation using various recording devices such as the record sheet set forth on page 121.

(4) *Attitudes*: Growth in attitudes may be evaluated by direct observation. Attitudes are behavior traits which tell us how students feel and react as they pursue their science studies. There are seven general attitudes which the student should acquire in the process of engaging in science activities. Each of these seven general attitudes may be subdivided into "clusters" of behavior traits. Teachers no doubt will interpret student growth in attitudes in terms of the clusters of behavior traits. The seven general attitudes subdivided into behavior trait "clusters" are shown below.

GENERAL ATTITUDES	BEHAVIOR CLUSTERS
1. Self Respect	Initiative Punctuality Perserverence Self-reliance Fruitful habits of work Concentration Working with a purpose Accepting helpful criticism
2. Creativeness	Self expression in; drawing writing reporting constructing collecting
3. Scientific Attitude	Research attitude Reliance on authority Open-mindedness Suspended judgment Avoidance of prejudice

GENERAL ATTITUDES	BEHAVIOR CLUSTERS
4. Cooperation (in group work)	A willingness to; contribute ideas cooperate with others respect the rights and views of others
5. Responsibility	Care in using materials Dependability as a group member Adherence to group regulations
6. Social Concern	Interest in progress of group Consideration of feelings of others Adaptability in group relations
7. Reverence	Respect for the scientist's work Respect for the immensity of the universe Respect for nature's law and order

Note: Some of the behavior traits listed above may be further defined as follows:

Initiative; readiness to try something not tried before.

Open-mindedness; refusal to accept as final a given view or opinion on a subject.

Reliance on authority; not taking hearsay for granted.

Self-reliance; attacking a problem without depending too much on others.

Research attitude; knowing that one learns through mistakes and reverses, and by trial and error.

Fruitful habits of work; finding something to do if finished before others.

Concentration; not easily distracted.

Working with a purpose; the student is so motivated that he continues to work on the problem out of class.

Consideration of others; willingness to listen to the point of view of others.

Adaptability; willingness to follow as well as lead.

EVALUATION METHODS AND DEVICES

Three types of evaluation devices should be used in the total appraisal of the student's growth. They are: (1) paper-and-pencil tests, (2) direct observation by the teacher, and (3) direct contact with the students.

(1) *Paper-and-Pencil Tests*: These are tests for information and understanding in science.
   (a) Essay tests

(b) Objective tests, including true-false, completion, matching, multiple choice.

(c) Tests involving diagrams, pictures, and charts.

(2) *Direct Observation by the Teacher*:

(a) Appraisal of special skills: e.g. setting up apparatus, keeping orderly notebooks, setting up well arranged collections, planning scrapbooks.

(b) Appraisal of individual work: e.g. skill in reading, reporting, writing, and listening; ability to do clear thinking; habits of neatness, open-mindedness, promptness.

(c) Appraisal of group work; e.g. evidence of effective "group dynamics" such as leadership, cooperation, tolerance, pointed discussion, taking part without dominating.

(3) *Direct Contact With Students*:

(a) Appraising student reaction when assignments are made.

(b) Appraising student initiative and resourcefulness in preparing reports.

(c) Appraising student reports according to particular criteria.

(d) Judging student behavior during study sessions, research periods, etc.

SUGGESTIONS REGARDING PAPER-AND-PENCIL TESTS

The essay test:

This test contains questions answered in essay form. It is by no means old-fashioned or out-of-date, and should continue to be an essential part of a total evaluation program. Although the score of an essay test is likely to be less reliable than that of an objective test, the essay test does evaluate the ability of pupils to think, to organize ideas, to use good English, and to master a science vocabulary. It is possible that the trend toward the extreme use of objective tests has done much to lower the standards of English in our schools.

Objective or new-type test:

These tests consist of short answers. The scoring is not affected by the teacher's subjective opinion. The objective test is answered by having the pupils encircle, underline, or supply letters, numbers, words, short phrases or sentences.

Understandings in science are best tested by the essay type questions, but the objective test may also be used for this purpose. For example:

(1) Understandings resulting from experimental work: An experiment is described in paragraph form and a series of essay or objective questions are listed for pupils to answer.

(2) Understandings resulting from graph studies: Students are given graphical illustrations of facts and are asked to draw conclusions.

(3) Understandings from diagram studies: Students are provided with labelled diagrams and are asked to identify the labelled parts and to explain their function.

SPECIAL RECORD FORMS FOR APPRAISING STUDENT BEHAVIOR

The following records are considered valuable in this program:

1. Recording the results of paper-and-pencil tests: Such tests are used to test facts, information, principles, understandings, and certain skills and habits. This method of record-keeping is familiar to all teachers.

2. Recording growth in skills, abilities and habits. Observation records should be kept of such growth as English performance in oral and written work, use of references, quality of science drawings, etc.

3. Recording attitudes: A record should be kept of such observed growth in behavior as self-respect, creative ability, scientific attitude, cooperation, sense of responsibility, and social concern.

Suggested Appraisal Forms:

In preparing a record sheet, a good plan is to tabulate about six types of behavior. The teacher may use a system of pluses and minuses, letters, or numbers to expedite the appraisal work.

A 5-point judgment-scale based on the method of direct observation is proposed below: (The evaluation of traits from "strong" to "weak" may be made by using such broad categories as A-B-C-D-E, or H-A-B-C-D, or 1-2-3-4-5.)

SUGGESTED EVALUATION FORM TO APPRAISE SKILLS, ABILITIES, AND HABITS

RECORD SHEET: GROWTH IN WORK METHODS: (skills, abilities, habits)
UNIT: IX-1. (May be used for several units cumulatively)

Names of Students	Reads widely and with comprehension	Uses correct and adequate English	Able to hold class attention when reporting	Habit of neatness in written work	Organizes information and ideas well	Works to ability level
Class IX-a	A-B-C-D-E	A-B-C-D-E	A-B-C-D-E	A-B-C-D-E	A-B-C-D-E	A-B-C-D-E
N. Abrams	B	B	C	C	C	A
L. Brooks						

A similar form proposed to record growth in attitudes is shown below.

SUGGESTED EVALUATION FORM TO APPRAISE ATTITUDES

RECORD SHEET: GROWTH IN ATTITUDES
UNIT: VIII-2. (Or the record may be used for several units cumulatively)

Names of Students	Self-respect	Creativeness	Scientific attitude	Co-operation in group work	Sense of responsibility	Social concern in group action
Class IX-b	1-2-3-4-5	1-2-3-4-5	1-2-3-4-5	1-2-3-4-5	1-2-3-4-5	1-2-3-4-5
L. Anson	3	3	4	3	3	5
M. Brown						

Record forms used in an evaluation program must be practical. They must be suited to the local situation. In a non-departmentalized school in which the teacher meets one class all day, detailed and lengthy paper-recording of attitudes and work habits is not necessary. Behavior traits such as pupil initiative, promptness, cooperation, and so on, are so frequently observed that elaborate written records are not required.

The system of block scheduling cuts down on departmentalization and thus should assist the teacher to know pupils more intimately. Direct observation of behavior will enable the teacher to evaluate more effectively student growth in those habits and attitudes which are difficult to measure by means of paper-and-pencil tests.

In highly departmentalized schools, where a teacher meets a class for science only, the lack of intimate acquaintance with the pupils calls for more detailed records. Without this carefully recorded information, a proper appraisal of the student's growth in habits, skills, attitudes and interests, cannot be made when required.

SUMMARY OF EVALUATION PRINCIPLES

Effective evaluation of the science program should:

1. Appraise the general and specific science objectives which are basic to the philosophy of the course.
2. Evaluate the child's total behavior or reaction to the science unit studies.
3. Evaluate growth in understandings, abilities, attitudes.
4. Appraise accuracy of expression in the language of science, correct spelling, and use of science vocabulary.

APPENDIX A

SOURCE BOOK AND REFERENCES

Textbooks are an invaluable aid in this science program and constitute one of the most important learning tools. The books to be used in the course are listed under three headings: 1. Primary Reference or Source Book, representing an essential book for each pupil; 2. Secondary References, representing essential books for each grade or class and 3. General Reference Books for the Junior High School Science Library, representing valuable material for all three junior high school grades.

The science program has been designed so that students use one common or primary source book as a basis for initial orientation to the units. Each pupil must have a copy of the primary source book. Student ideas should be enriched by using additional books. On certain sections of the course more detailed information will be required for reports and classroom discussion than is to be found in the primary source book. At no time should a single book or text be viewed as the total curriculum nor as containing minimum essentials. In committee work, it might be well to hold one group of students responsible for bringing to the discussion the material which one particular book has to offer on a given subject, and other students to bring data from different references, including the encyclopedia.

The books recommended for the Grade VII, VIII and IX programs are as follows:

REFERENCES FOR GRADE VII

A. Primary Reference or Source Book

Exploring Modern Science (Alberta edition) (Smith and Trafton)

B. Secondary References:

Science Problems—Book 1 (1951 edition) (Beauchamp, Mayfield & West).

Basic Science Education Series (Inexpensive paper-bound booklets)

No. 5 Stories Read From Rocks
No. 8 Magnets
No. 12 Machines
No. 38 Beyond the Solar System
No. 58 Adaptation to Environment
No. 69 Animal World

Our World Changes (Powers et al)

REFERENCES FOR GRADE VIII

A. Primary Reference or Source Book

Enjoying Modern Science (Smith and Jones)

B. Secondary References:

Basic Science Education Series (Booklets)

No. 14 Electricity
No. 36 The Sun and Its Family
No. 43 Ways of the Weather
No. 48 Earth's Changing Surface
No. 54 Balance in Nature
No. 68 Matter and Molecules
No. 70 Plant World

Note: Booklet No. 70 and booklet No. 14 are practically indispensable in handling Units 1 and 6.

Understanding The Universe—Book 3 (Carroll)

REFERENCES FOR GRADE IX

A. Primary Reference or Source Book

Using Modern Science (Smith and Jones)

Pamphlets by the Departments of Education and of Agriculture available as of September 1, 1951. These contain reference materials for Units 1, 2 and 4 of Grade IX. Initial copies will be distributed free of charge.

B. Secondary References:

Science: Story of Progress and Discovery (Davis and Sharpe)

GENERAL REFERENCE BOOKS FOR THE JUNIOR HIGH SCHOOL SCIENCE LIBRARY

A. Enrichment Series for Retarded Readers in Junior High School:

Discovering Our World, Books 1, 2, 3, (Beauchamp et al).

B. Books for General Class Use in Junior High School:

Wonderland of Science Series, (Meister et al), Grades VII, VIII, IX.

Text on Conservation (Audubon Society of Canada)

Adventures in Science—Our Environment Series, Grades VII, VIII, IX (Wood and Carpenter)

Interpreting Science Series—Understanding Our Environment; Our World; The Universe; Grades VII, VIII, IX (Carroll).

C. Enrichment Books for Accelerated Readers in Junior High School:

Science for Better Living, one book, (Brandwein et al).

Basic Science, one book (Barnard and Edwards).

Modern Wonder Book of Knowledge (Prepared by Carlisle et al).

This list in the general reference group will provide an adequate science library for the junior high school grades. It contains materials suited to grades VII, VIII, or IX, singly or in any combination.

TEACHERS' REFERENCES

The following books are of value to teachers who are interested in improving their background in the modern philosophy of science teaching.

Modern Science Teaching (Heiss, Osbourn, Hoffman), 1950.

Science Education in American Schools: National Society for the Study of Education, Forty-Sixth Yearbook, Part 1, 1947.

Science in General Education: Report of the Committee on the Function of Science in General Education. Commission on Secondary Curriculum, 1938.

The Measurement of Understanding: National Society for the Study of Education, Forty-fifth Yearbook, Part 1, 1946.

The Science Teacher: A science magazine to which teachers might like to subscribe. Subscription rate $1.50 per year. National Science Teachers Association, 1201 Sixteenth St., N.W. Washington 6, D.C., U.S.A.

Human Destiny: DuNouy. An interesting but philosophical attempt by a modern physicist to reconcile science with an idealistic philosophy of life. He postulates a telic or purposeful universe and proposes a theory of man's place in this universe. In his endeavor to explain the meaning of man's existence on earth, he argues that the strictly materialistic theory of space and time is no longer tenable.

APPENDIX B

APPARATUS, EQUIPMENT, AND MATERIALS FOR JUNIOR HIGH SCHOOL SCIENCE

Because many centres have both grades VII and VIII in the same school, but no grade IX, the required equipment for Junior High School science has been drawn up in four separate lists.

LIST A contains minimum apparatus, equipment and materials to be purchased for Grades VII and VIII.

LIST B contains additional minimum appartatus, equipment and materials to be purchased for Grade IX.

LIST C contains more expensive equipment to be purchased as funds permit.

LIST D contains material which may be obtained locally or equipment which can be easily improvised.

In schools where Grades VII, VIII, and IX exist, all the equipment in lists "A" and "B" will be required.

LIST "A" MINIMUM APPARATUS EQUIPMENT AND MATERIALS TO BE PURCHASED FOR GRADES VII AND VIII

Quantity	Item	Remarks
1 quart	Alcohol, wood	not needed in schools equipped with gas.
1	Alcohol Lamp	not needed in schools equipped with gas.
4 oz.	Alum	
1	Ammeter-Voltmeter	to test strength of voltaic and dry cells.
1 pound	Baking Soda	to counteract acids.
1	Ball and Ring Set	to illustrate expansion due to heat.
1	Battery Jar, small	
4	Beakers, Pyrex, 600 c.c.	
4	Beakers, Pyrex, 400 c.c.	
4	Beakers, Pyrex, 250 c.c.	
2	Beakers, Pyrex, 100 c.c.	
1	Beaker Tong, 8"	
1 set	Capillary Tubes	
1	Cart	for inclined plane.
4	Clamps, retort stand, 6"	
2	Clamps, rubber tubing	
1	Compass Needle, on stand	
1	Conducto Meter	to show rate of conductivity of metals

Quantity	Item	Remarks
2	Copper Strips, 5"x1"	for voltaic cell
1 set	Cork Borer	
1 pkg.	Corks, Assorted	
2	Crucibles, 60 m.m.	No. 0, approx. ¾" diameter
1	Crucible Tongs	
1	Deflagrating Spoon	
1	Doorbell, Electric	
2	Dry Cells	
2	Electric Switches, knife type, single blade	
2	Evaporating Dish, porcelain, 60 mm.	
1 pkg.	Filter Paper, 4" diameter	
1 pkg.	Filter Paper, 6" diameter	
1	File, Triangular	
1	Florence Flask, Pyrex, flat Bottom 1000 c.c.	
6	Florence Flask, Pyrex, flat Bottom, 125 c.c.	
2	Funnels, Glass, 60 mm. diam.	
1 box asst'd	Fuses, Car Fuses 2 to 10 amps.	
1	Fuse, House	
6	Glass Plates, 4" square	
1	Graduate, cylindrical, 100 cc.	
100	Insect Pins, assorted	
1	Iodine, Solution	small bottle, labelled
½ pound	Iron Filings, fine	
1	Iron "U"	soft; for electromagnet
1	Killing Bottle, insect	labelled "Poison"
2	Lamp Chimneys	for convection experiment with shoe box, and filtration expt.
2	Lead Strip 5"x1"x¼"	for voltaic cell
1 pkg.	Limewater Tablets	to test CO_2
1 vial	Litmus Paper, Blue	
1 piece	Lodestone	
½ oz.	Magnesium Ribbon	to show rapid oxidation in air
1	Magnet, Permanent, horseshoe type	
2	Magnet, Permanent, bar type 6" steel	
½ pound	Manganese Dioxide	for making oxygen, Certified pure
1 pkg.	Marble Chips	to make carbon dioxide
2"	Medicine Dropper	
1 pound	Mercury	
2	Meter Stick	
1	Motor, Toy, electric	
25 feet	Nichrome Wire	to show poor electrical conductivity
1 pound	Nitric Acid	for voltaic cell and making CO_2, C.P. undiluted, Mark "Poison"
½ dozen	Pith Balls	to show effects of frictional electricity
1 pound	Potassium Chlorate	to make oxygen
1	Pulley	for inclined plane

Quantity	Item	Remarks
2	Pulleys, Double, bakelite, approx. 2"	
2	Pulleys, Single, bakelite, approx. 2"	
2	Retort Stand, metal	
3	Rings for Retort Stand, 3", 4", 5"	
1	Rod, Ebonite	for frictional electricity
1	Rod, Glass	for frictional electricity
1	Spring Balance	graduated in grams and ounces, 2000 g. or 64 oz.
¼ pound	Starch, Corn	to test for starch
1 pkg.	Stoppers, Rubber	assorted, one-hole and two-hole to fit glassware
1 pound	Sulphuric Acid	for voltaic cell: CARE! Dilute by adding acid to water, not water to the acid
2	Test Tube Brush	
3	Test Tube Holder	clamp type
12	Test Tubes, Pyrex 6" x ¾" approx.	
12	Test Tubes, Pyrex 4" x ½" approx.	
1	Test Tube Rack, varied sizes of holes	
2	Thermometer, graduated in Fahrenheit and Centigrade	
3	Thistle Tubes	
1	Torricellian Tube	for barometer
2 pounds	Tubing, Glass, assorted	
10 feet	Tubing, Rubber, ¼" inside	
1	Wheel and Axle	without stand; stand can be improvised
6	Wicks for Alcohol Lamp	
1 pound	Wire, Copper No. 22 on spool, not insulated	
½ pound	Wire, Double cotton covered, No. 24	
2	Wire Gauze, square, asbestos centered, 5"	
½ pound	Wire, Magnet, enamelled, No. 24	
2	Zinc Strip, 5"x1"	

LIST "B" ADDITIONAL MINIMUM EQUIPMENT TO BE PURCHASED FOR GRADE IX

Quantity	Item	Remarks
1	Block and Tackle, model	
1	Electric Light Socket	porcelain, as used in ceilings of cellars
1	Electromagnet, horseshoe type	
1	Globe, earth	as used in Social Studies 12" diam.
1	Lift Pump, Glass Model	
1	Steam Engine, Toy Model	
1 pkg.	Wire, Picture, twisted or braided	

LIST "C" MORE EXPENSIVE EQUIPMENT TO BE PURCHASED AS FUNDS PERMIT

Quantity	Item	Remarks
1	Ammeter-Voltmeter	sensitive, galvanometer type, for use in 3rd experiment, Unit VIII-6
1	Barometer, Aneroid	glass covered in metal case, pocket watch type
1	Compass Needle	
1	Dipping Needle	
1	Hygrometer, wet and dry bulb	
1 set	Lenses, set of 6	for magnifying glass, and for telescope work
1	Magnet, Permanent, bar type, Alnico	
1	Microscope	65X to 200X
1	Steam Engine, Cross Section model	
1	Telegraph Key and Sounder	

LIST "D" EQUIPMENT WHICH MAY BE OBTAINED LOCALLY OR MATERIAL EASILY IMPROVISED

Quantity	Item	Remarks
As needed	Alcohol Lamp	using ink bottle
As needed	Balloons, Toy	
1	Board, Smooth 24" x 4"	for inclined plane
6	Candles	
1	Cart, Toy	or toy automobile for inclined plane
	Chalk	to make carbon dioxide
1	Electromagnet	improvised
	Expansion and Contraction Apparatus	
1 piece	Fur, cat's, or any other type	
1	Flashlight	student may bring one from home
3	Flower Pots	
3	Knitting Needles, or darning needles	for making magnets
	Old Electric Appliances (toaster, iron, fuses, bulbs, switches, radio tubes, dry cells, storage battery, telephone receiver, radio and loud speaker, etc.)	
1	Retort Stand, wood base, ¼" iron rod bolted in base	
2	Saucers	as evaporating dishes
4 (pint size)	Sealers, Glass	collect gases and for voltaic cell
4 (quart size)	Sealers, Glass	to collect gases, and for voltaic cell
1	Test Tube Rack	
4	Tin Cans	with tops carefully cut away
1	Wheel and Axle	improvise from spool and pencil, etc.
1	Windlass